RIGGING HANDBOOK

The complete illustrated field reference

4th Edition

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FOURTH EDITION

June 2012

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This publication DOES NOT provide a comprehensive or exhaustive list of all the possible situations encountered with rigging and hoisting operations.

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Jerry A. Klinke

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Fourth Edition - 1st printing, June 2012

Disclaimer

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Introduction - *by Jerry Klinke*

You will notice that this 4th edition of the Rigging Handbook greatly expands on the content of the earlier editions, and that the 350+ illustrations are sharper and more detailed.

The layout of the book has changed slightly, and organized in a more logical manner, with side tabs renamed to help find things a little easier. Much of the new content and illustrations are a result of feedback from the folks in the field, students in our rigging training classes.

This edition includes recent changes (the first since the 1970's) by the Occupational Safety and Health Administration (OSHA) related to rigging and hoisting activities.

You will also notice more emphasis on load share, and the importance it has on calculating tensions and selecting the right rigging equipment. Additional formulas have also been added that cover Center of Gravity and Load Share calculations.

And in the Hand Signal section, emphasis is placed on the new OSHA regulations for signal persons, along with some examples of crane dynamics and typical voice signals used for directing cranes.

Shackles and eyebolts in the Hardware section have also seen some new content changes due to todays products and manufacturing technologies.

Additional content was added in the Operations section that covers some of the ways a load can be rigged and how these methods can affect load control. You will also find some new information on cribbing, taglines and pre-lift checklists.

I want to thank Neil Hays who scrutinized the book for errors and other mistakes I overlooked, and provided valuable insight on ways to improve many of the examples used. Without his assistance and valuable advice, this book would have never made it this far.

"Rig smart - Rig safe"!

June 2012

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Safe operating practices (OSHA 1910.184)

Whenever any sling is used the following practices shall be observed:

1. Slings that are damaged or defective shall not be used.
2. Slings shall not be shortened with knots or bolts or other makeshift devices.
3. Sling legs shall not be kinked.
4. Slings shall not be loaded in excess of their rated capacities.
5. Slings used in a basket hitch shall have the loads balanced to prevent slippage.
6. Slings shall be securely attached to their loads.
7. Slings shall be padded or protected from the sharp edges of their loads.
8. Suspended loads shall be kept clear of all obstructions.
9. All employees shall be kept clear of loads about the be lifted and of suspended loads.
10. Hands or fingers shall not be placed between the sling and its load while the sling is being tightened around the load.

11 Shock loading is prohibited.

12. A sling shall not be pulled from under a load when the load is resting on the sling.

Inspections - Each day before being used, the sling and all fastenings and attachments shall be inspected for damage or defects by a competent person designated by the employer. Additional inspections shall be performed during sling use where service conditions warrant. Damaged or defective slings shall be immediately removed from service.

The information contained in this book is NOT a substitute for formal training and education on rigging and hoisting operations.

A proper blend of classroom and hands-on training with the right mix of on-the-job training will help develop competent and skilled people with rigging skills.

This publication DOES NOT provide a comprehensive or exhaustive list of all the possible situations encountered with rigging and hoisting operations.

The information contained in this publication was obtained from sources believed to be reliable at the time this publication was written. It should not be assumed that this material covers all the regulations, or standards used in the industry. Suggested procedures should not, therefore, be used without first securing competent engineering advice for any given application.

OSHA has updated its standards regulating slings for general industry (§1910.184) and construction (§1926.251) **This final rule became effective on July 8, 2011**

In summary, the new changes include:

1. 1926.251(c)(16) - Wire rope slings shall have permanently affixed, legible identification markings stating size, rated capacity for the type(s) of hitch(es) used and the angle upon which it is based, and the number of legs if more than one. **Employers now must use only slings with permanently affixed identification markings that show the maximum load capacity for each sling.**
2. 1926.251(f)(1) - Employers must not use shackles with loads in excess of the rated capacities (i.e., working load limits) indicated on the shackle by permanently affixed and legible identification markings prescribed by the manufacturer.

The load capacity tables previously designated in the old 1971 OSHA standards are now obsolete. These outdated tables have now been replaced with the requirement that prohibits loading slings in excess of the recommended safe working load as shown on the permanently affixed identification markings.

Now ALL wire rope slings must be marked - no exceptions!

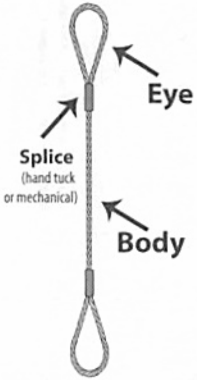
OSHA now prohibits the use of ANY sling that does not have a permanently affixed identification tag.

Reference to new laws: Federal Register/Vol. 76, No. 110/ Wednesday, June 8, 2011/Rules and Regulations/Page: 33591

Download OSHA "Cranes and Derricks in Construction: Final Rule" (29 CFR 1926.1400 Subpart CC) and related fact sheets at: **www.osha.gov/cranes-derricks/index.html** The "SMALL ENTITY COMPLIANCE GUIDE" also an excellent reference: www.osha.gov/cranes-derricks/small_entity.html

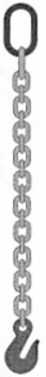
Types of Lifting Slings

Wire Rope


Eye
Splice
(hand tuck or mechanical)
Body

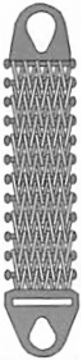
5:1 Design factor

Alloy Chain



4:1 Design factor

Metal Mesh

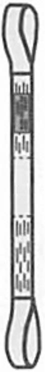


5:1 Design factor

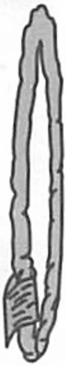
Synthetic

All are 5:1 Design factor

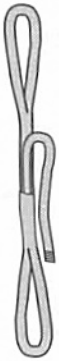
Web



Roundsling



Rope



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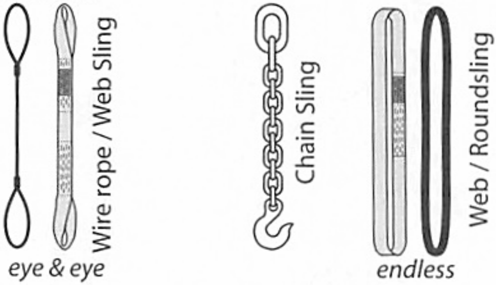
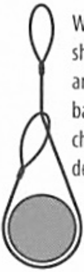
Basic Hitches

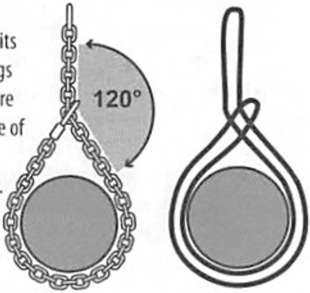
VERTICAL


Wire rope / Web Sling
eye & eye
Chain Sling
endless
Web / Roundsling

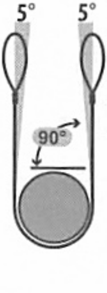
CHOKER



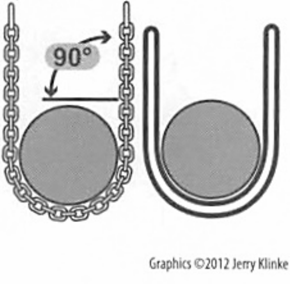
Working Load Limits shown on sling tags and other charts are based on the angle of choke to be 120 degrees or greater.



BASKET



Working Load Limits shown on sling tags and capacity charts **are based on both legs being vertical within 5 degrees.**



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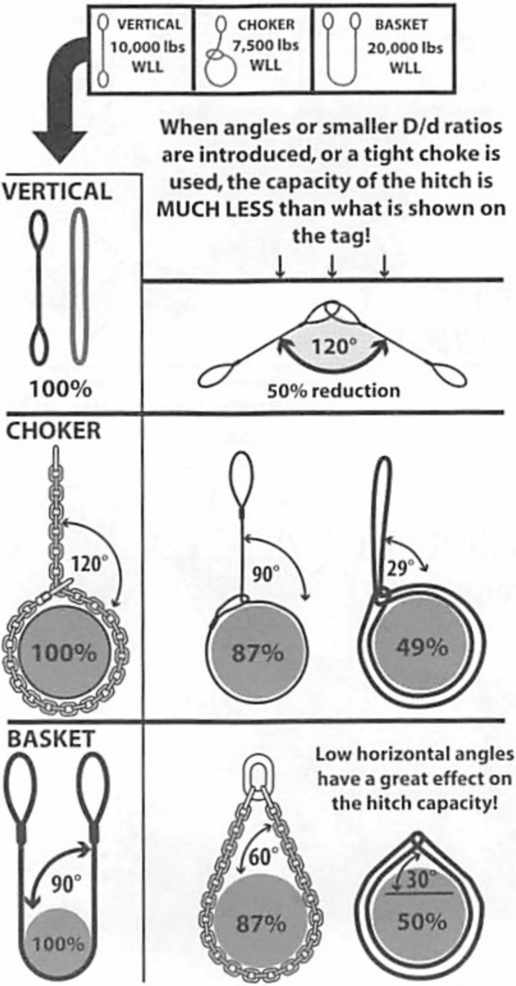
Basic Hitch Ratings

Capacity charts and the sling tags show the Working Load Limit (WLL) for each hitch based on the examples in the left column.

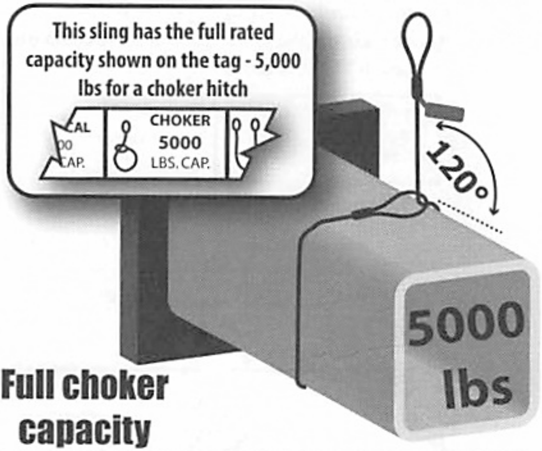

VERTICAL
10,000 lbs
WLL
CHOKER
7,500 lbs
WLL
BASKET
20,000 lbs
WLL
VERTICAL
100%
120°
50% reduction
CHOKER
120°
100%
90°
87%
29°
49%
BASKET
90°
100%
60°
87%
30°
50%

When angles or smaller D/d ratios are introduced, or a tight choke is used, the capacity of the hitch is MUCH LESS than what is shown on the tag!

Low horizontal angles have a great effect on the hitch capacity!

Graphics ©2012 Jerry Klinke

Choker hitch reductions

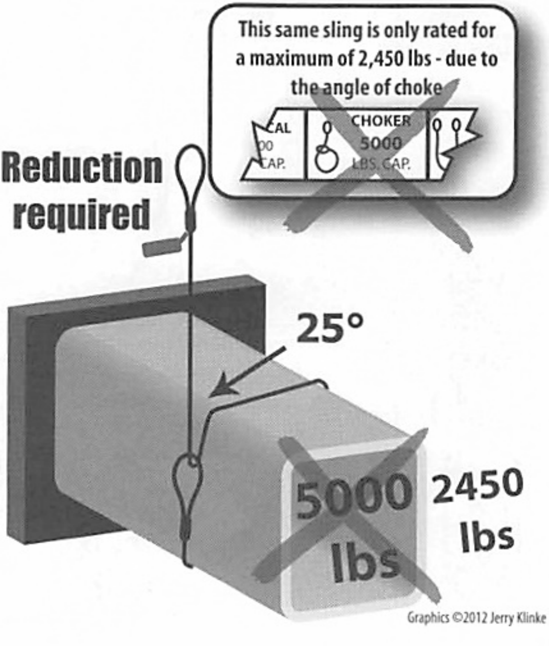


This sling has the full rated capacity shown on the tag - 5,000 lbs for a choker hitch

CAL
00
CAP.
CHOKER
5000
LBS. CAP.
120°
5000
lbs

Full choker capacity

Reduction required

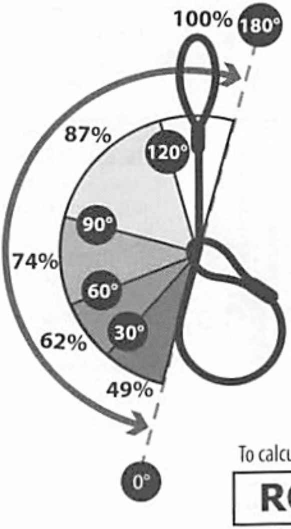


This same sling is only rated for a maximum of 2,450 lbs - due to the angle of choke

CAL
00
CAP.
CHOKER
5000
LBS. CAP.
25°
5000
lbs
2450
lbs

Graphics ©2012 Jerry Klinke

Choker hitch reductions


100%
180°
87%
120°
90°
74%
60°
62%
30°
49%
0°

"an angle of choke less than 120 degrees is not to be used without reducing the rated load of the sling"

ASME B30.9

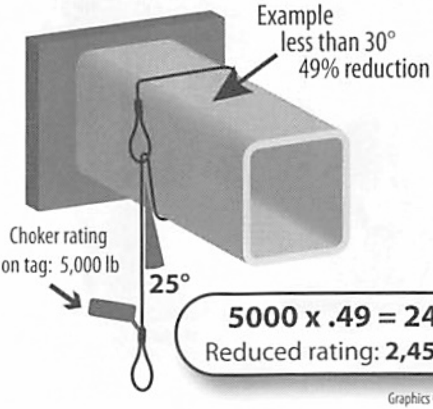
Choker hitch rated capacity adjustment

Angle of choke in degrees	Rated capacity
Over 120	100%
90 - 120	87%
60 - 89	74%
30 - 59	62%
0 - 29	49%

To calculate adjusted choker ratings:

$$\boxed{RC = C \times R}$$

C : Choker rating
R : Rated Capacity
RC : Reduced choker rating


Example
less than 30°
49% reduction
Choker rating
on tag: 5,000 lb
25°

5000 x .49 = 2450

Reduced rating: **2,450 lbs**

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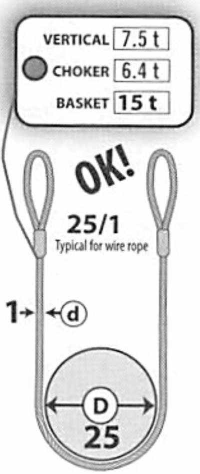
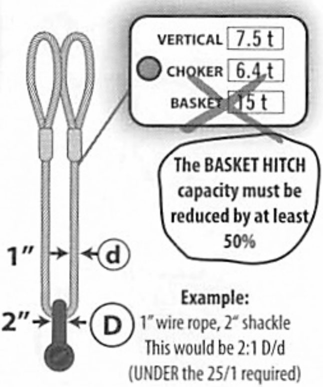
Basket hitches D/d


VERTICAL 7.5 t
CHOKER 6.4 t
BASKET 15 t
OK!
25/1
Typical for wire rope
1
d
D
25

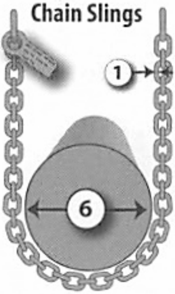

VERTICAL 7.5 t
CHOKER 6.4 t
BASKET 15 t
The BASKET HITCH capacity must be reduced by at least 50%
1″
d
2″
D

Example:
1″ wire rope, 2″ shackle
This would be 2:1 D/d
(UNDER the 25/1 required)

American Society of Mechanical Engineers (ASME)
Wire Rope Technical Board (WRTB)

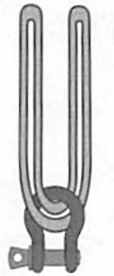
All slings lose capacity when they are bent too much. Basket hitch ratings are based on a MINIMUM diameter and the capacity must be reduced when under the minimum D/d. **EACH type of sling has a different minimum diameter**

Chain Slings



6:1 is the current D/d *that is recommended by the National Association of Chain Manufacturers (NACM)*

Roundslings



D/d varies for roundslings - consult the Web Sling & Tie Down Association (WSTDA) for details

Graphics ©2012 Jerry Klinke

Basic Hitches

All Working Load Limits (WLL) shown on slings are based upon the items being in new, unused condition.

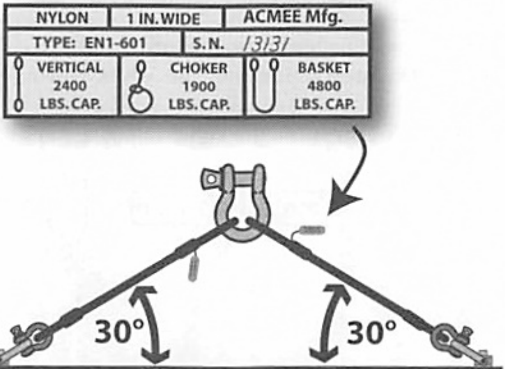
All rigging equipment is subject to wear, misuse, and overloading that may reduce the rated capacity of the equipment. It is required by OSHA and ASME standards that rigging equipment be regularly inspected to determine its condition. A competent person or engineering professional should then determine if the equipment can continue to be used at the rated capacity.

WLL's are based on one or more of the following factors:

(1) material strength
(2) design factor
(3) type of hitch
(4) angle of loading
(5) diameter of curvature (D/d)
(6) fabrication efficiency

See ASME B30.9 "SLINGS" for a full list of current requirements

Always refer to the sling tag for the capacity (WLL) of each sling - never rely on tables and charts to determine the capacity!

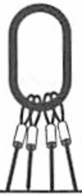


ASME B30.9-1.5.3 states "Horizontal sling angles less than 30 degrees SHALL NOT be used except as recommended by the sling manufacturer or a qualified person."

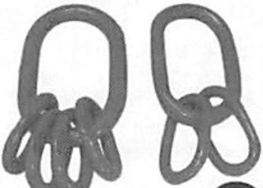
Graphics ©2012 Jerry Klinke

Bridle sling assembly

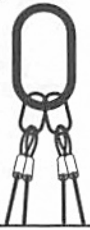
Masterlink ONLY



Masterlink Sub-Assembly



A masterlink-sub assembly provides better load distribution

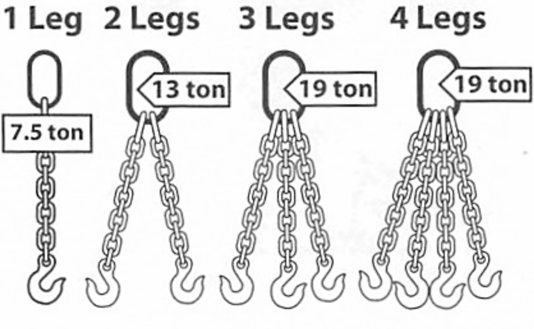


A Bridle sling assembly IS NOT a type of hitch!

ASME B30.9-0.2 only lists 3 hitches:
1) hitch, basket 2) hitch, choker 3) hitch, vertical - and they define a bridle as ***"a sling composed of multiple legs with the top ends gathered in a fitting that goes over the lifting hook"***

---

4 legs just means better load control, it DOES NOT increase the total capacity of the bridle assembly.



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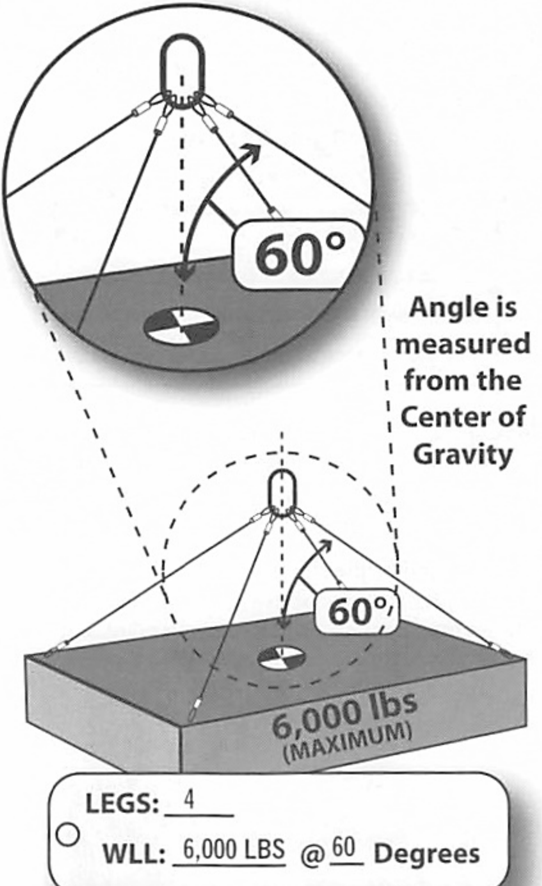
Bridle Sling Ratings



Angle is measured from the Center of Gravity

LEGS: 4

WLL: 6,000 LBS @ 60 Degrees

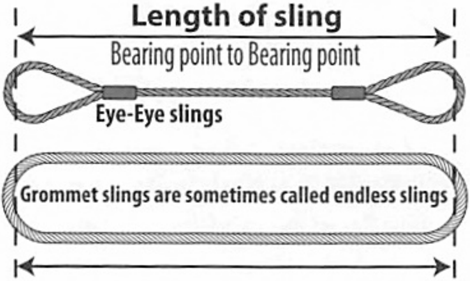
A sling TAG for bridles are based on:

1) Symmetrical loading
2) Horizontal angle
3) ALL sling legs being used

Graphics ©2012 Jerry Klinke

Sling lengths

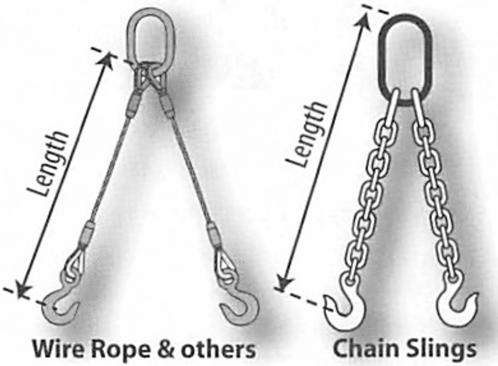
The length of a sling is determined from the bearing point to bearing point. The length or "reach" is an important number to know when ordering and selecting a sling.


Length of sling
Bearing point to Bearing point
Eye-Eye slings
Grommet slings are sometimes called endless slings

NOTE: If ordering a synthethic roundsling to replace a wire rope grommet sling, you need to inform the sling manufacturer of the measurement you are providing them with. Wire rope grommet slings use the circumference of the sling and not the bearing point distance

Multi-legged bridle slings:

The length dimension shown on a Chain Sling is always from bearing point to bearing point, but may not always be this way with other sling types


Length
Length

Wire Rope & others **Chain Slings**

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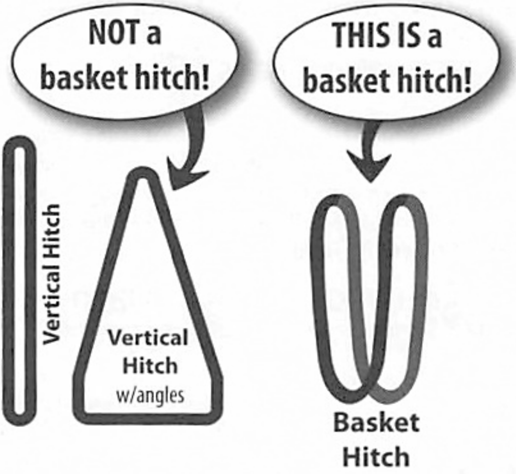
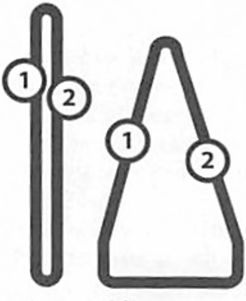
SLINGS
HARDWARE
FORMULAS
WEIGHTS
OPERATIONS
STANDARDS
HAND SIGNALS

Endless Sling Use

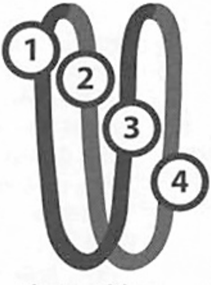
When using a roundsling or any endless sling, make sure you choose the correct hitch AND the correct WLL for the sling.


NOT a basket hitch!
THIS IS a basket hitch!
Vertical Hitch
Vertical Hitch w/angles
Basket Hitch

Just because the base is wider than the top of the hitch DOES NOT imply that it's a basket hitch. **A true basket hitch has twice the capacity of a vertical hitch because it has twice as many legs to support the load.**



2 Legs - each leg supports 50% of load



4 legs - each leg supports 25% of the load

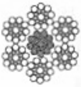
Graphics ©2012 Jerry Klinke

Wire Rope 101

Wire rope may be manufactured from many grades and types of steel and alloys, some of the more common grades are:

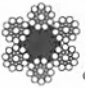
IPS	Improved Plow Steel: lowest minimum breaking force
EIPS	Extra Improved Plow Steel: minimum breaking force typically 15% higher than IPS
EEIPS	Extra Extra Improved Plow Steel: minimum breaking force typically 10% higher than EIPS

Usually a wire rope consists of a core member, around which a number of multiwired strands are "laid" or helically bent. There are two general types of cores for wire rope fiber cores and wire cores. The fiber core may be made from natural or synthetic fibers. The wire core can be an Independent Wire Rope Core (IWRC), or Fiber Core (FC).



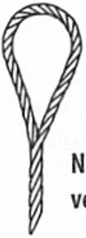
IWRC

A steel core, usually another wire strand



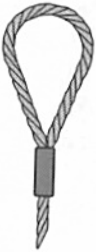
FIBER

A core composed of synthetic fibers



Hand splicing: Because no metal sleeve is required to secure the eye in the hand spliced sling, it exhibits more flexibility than mechanically spliced slings.. They have a more narrow profile and therefore can fit through tight spaces.

NOTE: Hand tucked slings used in a single leg vertical lift shall not be allowed to rotate.

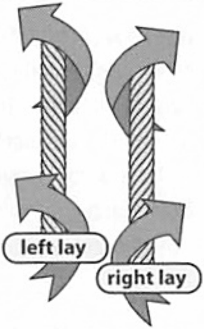


Mechanical splicing: Mechanically spliced eyes are economical, and offer the highest rated capacity of any spliced wire rope sling. It is fabricated by unlaying the rope body into two parts, one containing half the number of strands, the other having the remaining strands and core. The rope is unlayed far enough back to allow the eye to be formed by looping one part in one direction and the other part in the opposite direction and laying the rope back together. The strands are rolled back around the rope body and a metal sleeve is slipped over the ends and pressed (or swaged) to secure the ends to the sling body.

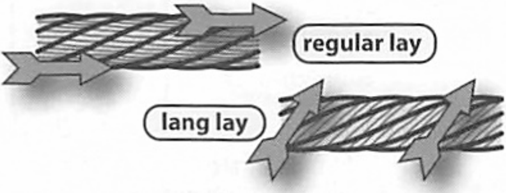
Graphics ©2012 Jerry Klinke

Wire Rope 101

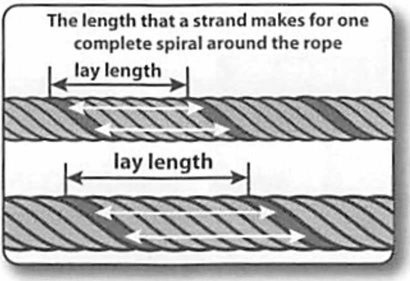
The "Lay" of a wire rope is simply a description of the way wires and strands are placed during construction. Right lay and left lay refers to the direction of strands. Right lay means that the strands pass from left to right across the rope, Left lay means just the opposite.


left lay
right lay

Regular lay and lang lay describes the way wires are placed within each strand. Regular lay means that wire in the strands are laid opposite in direction to the lay of the strands. Lang lay means that wires are laid in the same direction as the lay of the strands


regular lay
lang lay

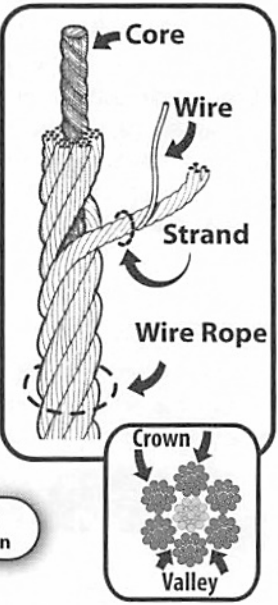
The lay as a unit of measure is the length a single strand extends in making one complete turn around the rope. Lay length is measured in a straight line parallel to the centerline of the rope; not by following the path of the strand.

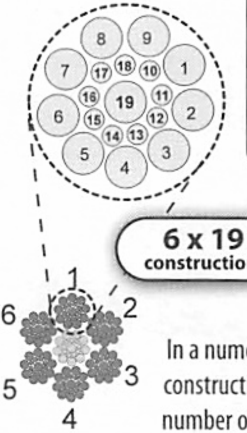

The length that a strand makes for one complete spiral around the rope
lay length
lay length

Graphics ©2012 Jerry Klinke

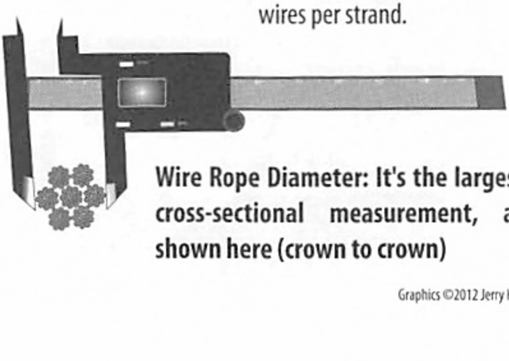
Wire Rope 101

Wire Rope is made of steel wires laid together to form a strand. These strands are laid together to form a rope, usually around a central core of either fiber or wire.


Core
Wire
Strand
Wire Rope
Crown
Valley


8
9
7
17
18
10
1
16
19
11
6
15
12
2
14
13
5
4
3
6 x 19
construction
1
2
3
4
5
6

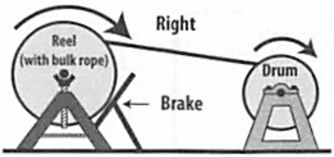
In a numerical classification of rope construction, the first number is the number of strands; the second is the number is the number of wires. Thus, 6x19 means six strands of nineteen wires per strand.



Wire Rope Diameter: It's the largest cross-sectional measurement, as shown here (crown to crown)

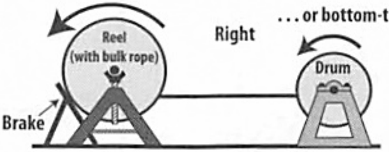
Graphics ©2012 Jerry Klinke

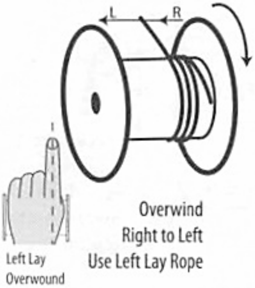
Wire Rope 101


Right
Reel
(with bulk rope)
Brake
Drum

When installing new wire rope from a reel it is important that the rope be wound top-to-top . . . .

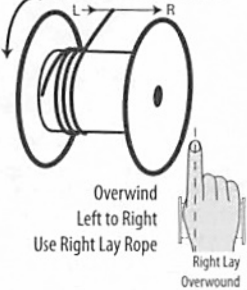
. . . or bottom-to-bottom


Reel
(with bulk rope)
Right
Drum
Brake

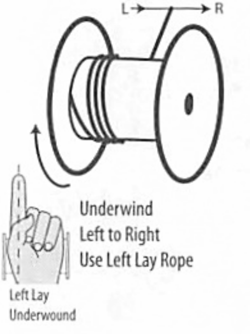

L
R
Left Lay
Overwound

Overwind
Right to Left
Use Left Lay Rope

Start rope at Left Flange

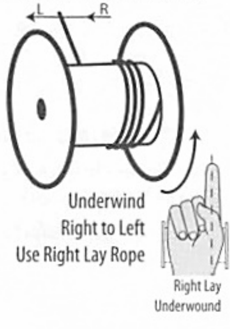

L
R
Right Lay
Overwound

Overwind
Left to Right
Use Right Lay Rope


L
R
Left Lay
Underwound

Underwind
Left to Right
Use Left Lay Rope

Start rope at Right Flange


L
R
Right Lay
Underwound

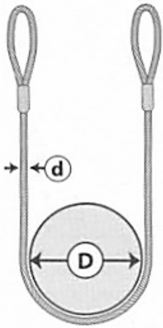
Underwind
Right to Left
Use Right Lay Rope

When loading a drum, extreme care must be taken to ensure the drum is properly loaded, and each wrap is wound tightly against the preceding wrap.

Graphics ©2012 Jerry Klinke

Wire Rope (Eye & Eye) D/d

BODY OF THE SLING

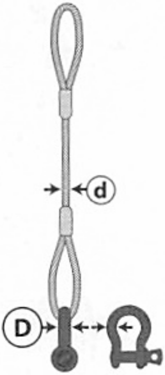


Single-part slings (ASME B30.9)

MS = 25/1 *(25 x rope diameter)*
HT = 15/1 *(15 x rope diameter)*
BRD = 25 x **component rope diameter**

MS = Mechanical splice / connection
HT = Hand tucked/spliced connection
BRD = Braided multi-part slings, 6 and 8 part

EYE OF THE SLING

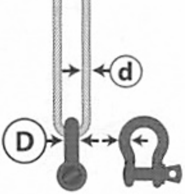


The shackle BODY diameter must be the same diameter (or larger) than the sling diameter.

Example:

1" wire rope, and a 1" shackle
This would be 1:1 D/d (UNDER the 25/1 required)
The sling capacity would be reduced by at least 50%

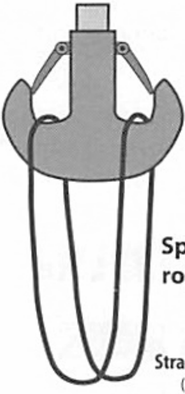
When D/d ratios are less than recommended, the rated load of the sling MUST be decreased - consult the sling manufacturer.



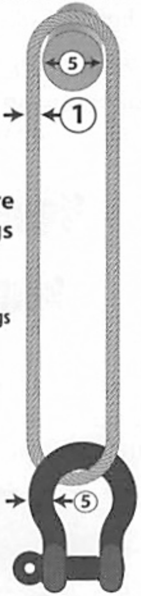
Reference: Wire Rope Technical Board "Reduction of efficiency of wire rope when bent over pins of various sizes"

Graphics ©2012 Jerry Klinke

Wire Rope (Grommet) D/d



EYE OF THE SLING

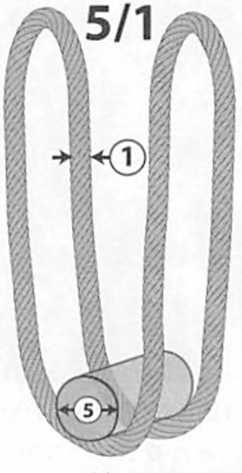


Specific only to wire rope grommet slings

Strand laid and cable laid slings
(WRTB*-Wire Rope Users Manual)
5/1 *(5 x rope diameter)*

Consult with sling manufacturer for D/d with other types of grommet slings

BODY OF THE SLING



**Reference: Wire Rope Technical Board*

5/1

The shackle BODY dia must be 5 times the sling dia

IF NOT, then the sling capacity must be reduced

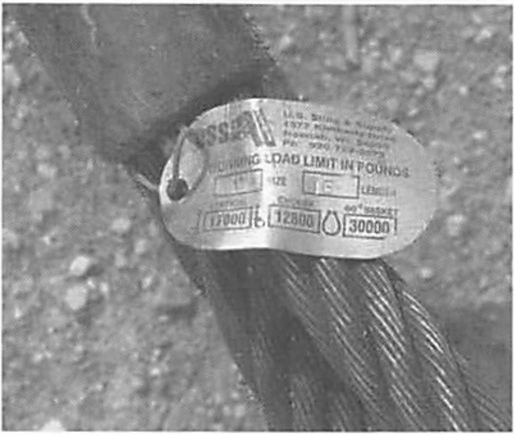
Graphics ©2012 Jerry Klinke

The capacity tables shown in this book are only intended to assist the user by providing typical sling data for job planning activities. Be aware than the sling capacities are different depending on each sling manufacturer!

For example; the capacity for a 1" 6x19 wire rope sling can range from 6.7 tons to over 11 tons, depending on the grade and manufacturer.

Never assume that all slings are the same!

This is why it is VERY IMPORTANT to always select and use all slings and rigging hardware by the rated capacity (WLL) shown on the ID tag as provided by the manufacturer.



OSHA prohibits the use of ANY sling that does not have a permanently affixed identification tag

Wire rope slings - Overview

ASME B30.9 - 2010

- Wire Rope Material -

1. Only new, unused, regular-lay wire rope shall be used for fabricating slings
2. Rotation-resistant wire rope shall NOT be used for fabricating slings
3. Wire rope clips shall not be used to fabricate wire rope slings - except where the application of slings prevents the use of prefabricated slings*
4. Malleable cast iron clips shall NOT be used to fabricate slings
5. Knots shall not be used to fabricate slings

- Configurations -

1. 6x19 and 6x36 slings and cable laid slings shall have a minimum clear length of rope 10 times the rope diameter between splices, sleeves, or end fittings
2. Braided slings shall have a minimum clear length of rope 40 times the component rope diameter between the loops or end fittings
3. Grommets and endless slings shall have a minimum circumferential length of 96 times the body diameter of the grommet or endless sling

unless approved by a qualified person.

- Temperature -

1. Fiber core shall not be exposed to temperatures in excess of 180°F (82°C).
2. When IWRC wire rope slings are to be used at temperatures above 400°F (204°C) or below - 40°F (- 40°C), the sling manufacturer should be consulted.

- Chemically Active Environments -

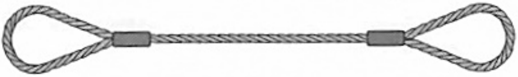
1. The strength of wire rope slings can be degraded by chemically active environments. This includes exposure to chemicals in the form of solids, liquids, gases, vapors, or fumes. The sling manufacturer or qualified person should be consulted before slings are used in chemically active environments.
2. Fiber core wire rope slings should not be subjected to degreasing or a solvent because of possible damage to the core.

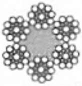
- Rigging Practices -

1. Slings shall not be shortened or lengthened by knotting, twisting, or by wire rope clips or by any unapproved methods.
2. Slings in contact with edges, corners, or protrusions should be protected with a material of sufficient strength, thickness, and construction to prevent damage to the sling.
3. Loads should not be rested on the sling, or be pulled out from under a load
4. Only choke on the sling body, not on a splice or fitting.
5. An object in the eye of a sling should not be wider than 1/2 the length
6. The load shall not be allowed to rotate when hand tucked slings are used in a single leg vertical lift.
7. Slings made with wire rope clips shall not be used as a choker hitch.

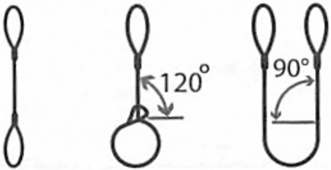
EIPS - MS

6x19 and 6x36 class
1-part wire rope sling





FIBER CORE



SIZE	VERTICAL	CHOKER	BASKET
1/4"	0.56	0.42	1.1
5/16"	0.87	0.66	1.7
3/8"	1.2	0.94	2.5
7/16"	1.7	1.3	3.4
1/2"	2.2	1.6	4.4
9/16"	2.7	2.1	5.5
5/8"	3.4	2.6	6.8
3/4"	4.8	3.7	9.7
7/8"	6.6	5	13
1"	8.3	6.4	17
1-1/8"	10	8.1	21
1-1/4"	13	9.9	26

Rated capacities shown are in US Tons (2,000 lb)

Rated capacities are based on:

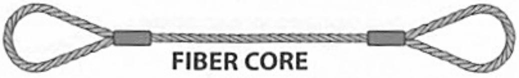
1) Basket hitches with a D/d ratio of 25/1 or greater
2) Basket hitches with vertical legs (within 5°)
3) Choker hitch, angle of choke used = 120° or greater
4) Shackle diameter no smaller than the sling diameter
    a) applies to the bare eye of the sling
    b) does not apply to sling eyes with thimbles

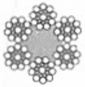
ASME B30.9

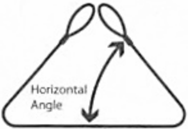
These capacity tables contain typical capacity values based on ASME B30.9 standards and are for reference only. The manufacturers sling tag must be used to obtain the actual capacity of the equipment being used, since these values may vary from the actual capacity shown on the tag.

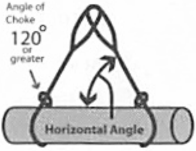
EIPS - MS

6x19 and 6x36 class
1-part wire rope sling









Basket			2-Chokers	
60°	30°	*SIZE*	60°	30°
0.97	0.56	**1/4"**	0.73	0.42
1.5	0.87	**5/16"**	1.1	0.66
2.2	1.2	**3/8"**	1.6	0.94
2.9	1.7	**7/16"**	2.2	1.3
3.8	2.2	**1/2"**	2.9	1.6
4.8	2.7	**9/16"**	3.6	2.1
5.9	3.4	**5/8"**	4.5	2.6
8.4	4.8	**3/4"**	6.3	3.7
11	6.6	**7/8"**	8.6	5
14	8.3	**1"**	11	6.4
18	10	**1-1/8"**	14	8.1
22	13	**1-1/4"**	17	9.9

Rated capacities shown are in US Tons (2,000 lb)

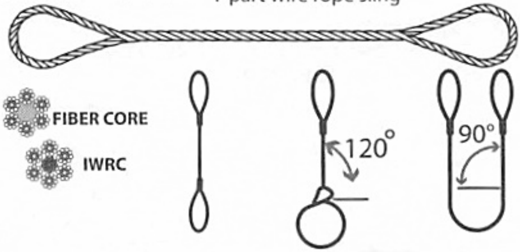
Rated capacities are based on:

1) Basket hitches with a D/d ratio of 25/1 or greater
2) Basket hitches with vertical legs (within 5°)
3) Choker hitch, angle of choke used = 120° or greater
4) Shackle diameter no smaller than the sling diameter
   a) applies to the bare eye of the sling
   b) does not apply to sling eyes with thimbles

These capacity tables contain typical capacity values based on ASME B30.9 standards and are for reference only. The manufacturers sling tag must be used to obtain the actual capacity of the equipment being used, since these values may vary from the actual capacity shown on the tag.

EIPS - HT

6x19 and 6x36 class
1-part wire rope sling



SIZE	VERTICAL	CHOKER	BASKET
3/8"	1.2	0.94	2.4
7/16"	1.6	1.3	3.2
1/2"	2.0	1.6	4.0
9/16"	2.5	2.1	5.0
5/8"	3.1	2.6	6.2
3/4"	4.3	3.7	8.6
7/8"	5.7	5	11
1"	7.4	6.4	15
1-1/8"	9.3	8.1	19
1-1/4"	11	9.9	23
1-3/8"	14	12	27
1-1/2"	16	14	32
1-5/8"	19	16	38
1-3/4"	22	19	44
1-7/8"	25	22	50
2"	28	25	56
2-1/8"	32	28	63
2-1/4"	35	31	70

Rated capacities shown are in US Tons (2,000 lb)

Rated capacities are based on:

1) Basket hitches with a D/d ratio of 25/1 or greater
2) Basket hitches with vertical legs (within 5°)
3) Choker hitch, angle of choke used = 120° or greater
4) Shackle diameter no smaller than the sling diameter
   a) applies to the bare eye of the sling
   b) does not apply to sling eyes with thimbles

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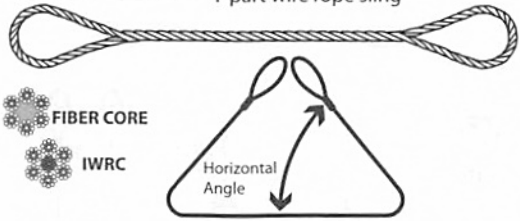
EIPS - HT

6x19 and 6x36 class
1-part wire rope sling



Basket & 2-leg bridle

SIZE	60 degrees	45 degrees	30 degrees
3/8"	2.0	1.7	1.2
7/16"	2.7	2.2	1.6
1/2"	3.5	2.9	2.0
9/16"	4.4	3.6	2.5
5/8"	5.3	4.4	3.1
3/4"	7.4	6.1	4.3
7/8"	9.8	8	5.7
1"	13	10	7.4
1-1/8"	16	13	9.3
1-1/4"	20	16	11
1-3/8"	24	19	14
1-1/2"	28	23	16
1-5/8"	33	27	19
1-3/4"	38	31	22
1-7/8"	43	35	25
2"	49	40	28
2-1/8"	55	45	32
2-1/4"	61	50	35

Rated capacities shown are in US Tons (2,000 lb)

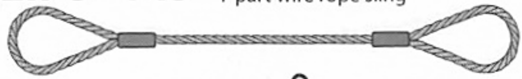
Rated capacities are based on:

1) Basket hitches with a D/d ratio of 25/1 or greater
2) Basket hitches with vertical legs (within 5°)
3) Choker hitch, angle of choke used = 120° or greater
4) Shackle diameter no smaller than the sling diameter
   a) applies to the bare eye of the sling
   b) does not apply to sling eyes with thimbles

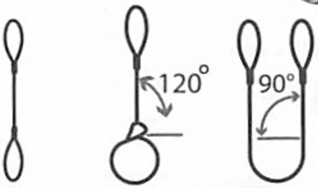
These capacity tables contain typical capacity values based on ASME B30.9 standards and are for reference only. The manufacturers sling tag must be used to obtain the actual capacity of the equipment being used, since these values may vary from the actual capacity shown on the tag.

EIPS - MS

6x19 and 6x36 class
1-part wire rope sling



IWRC



SIZE	VERTICAL	CHOKER	BASKET
1/4"	0.65	0.48	1.3
5/16"	1	0.74	2
3/8"	1.4	1.1	2.9
7/16"	1.9	1.4	3.9
1/2"	2.5	1.9	5.1
9/16"	3.2	2.4	6.4
5/8"	3.9	2.9	7.8
3/4"	5.6	4.1	11
7/8"	7.6	5.6	15
1"	9.8	7.2	20
1-1/8"	12	9.1	24
1-1/4"	15	11	30
1-3/8"	18	13	36
1-1/2"	21	16	42
1-5/8"	24	18	49
1-3/4"	28	21	57
1-7/8"	32	24	64
2"	37	28	73

Rated capacities shown are in US Tons (2,000 lb)

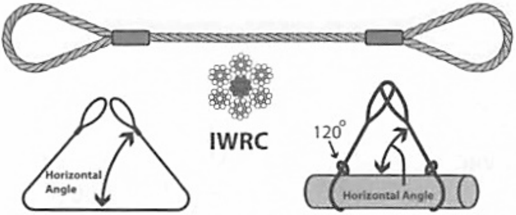
Rated capacities are based on:

1) Basket hitches with a D/d ratio of 25/1 or greater
2) Basket hitches with vertical legs (within 5°)
3) Choker hitch, angle of choke used = 120° or greater
4) Shackle diameter no smaller than the sling diameter
   a) applies to the bare eye of the sling
   b) does not apply to sling eyes with thimbles

These capacity tables contain typical capacity values based on ASME B30.9 standards and are for reference only. The manufacturers sling tag must be used to obtain the actual capacity of the equipment being used, since these values may vary from the actual capacity shown on the tag.

EIPS - MS

6x19 and 6x36 class
1-part wire rope sling



Basket			2-Chokers	
60°	30°	*SIZE*	60°	30°
1.1	0.65	**1/4"**	0.82	0.48
1.7	1	**5/16"**	1.3	0.74
2.5	1.4	**3/8"**	1.8	1.1
3.4	1.9	**7/16"**	2.5	1.4
4.4	2.5	**1/2"**	3.2	1.9
5.5	3.2	**9/16"**	4.1	2.4
6.8	3.9	**5/8"**	5	2.9
9.7	5.6	**3/4"**	7.1	4.1
13	7.6	**7/8"**	9.7	5.6
17	9.8	**1"**	13	7.2
21	12	**1-1/8"**	16	9.1
26	15	**1-1/4"**	19	11
31	18	**1-3/8"**	23	13
37	21	**1-1/2"**	28	16
42	24	**1-5/8"**	32	18
49	28	**1-3/4"**	37	21
56	32	**1-7/8"**	42	24
63	37	**2"**	48	28

Rated capacities shown are in US Tons (2,000 lb)

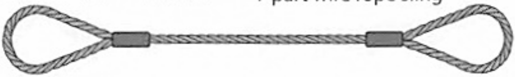
Rated capacities are based on:

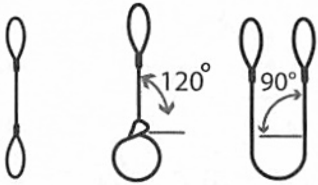
1) Basket hitches with a D/d ratio of 25/1 or greater
2) Basket hitches with vertical legs (within 5°)
3) Choker hitch, angle of choke used = 120° or greater
4) Shackle diameter no smaller than the sling diameter
   a) applies to the bare eye of the sling
   b) does not apply to sling eyes with thimbles

These capacity tables contain typical capacity values based on ASME B30.9 standards and are for reference only. The manufacturers sling tag must be used to obtain the actual capacity of the equipment being used, since these values may vary from the actual capacity shown on the tag.

EEIPS - MS

6x19 and 6x36 class
1-part wire rope sling





SIZE	VERTICAL	CHOKER	BASKET
1/4"	0.71	0.52	1.4
5/16"	1.1	0.81	2.2
3/8"	1.6	1.2	3.2
7/16"	2.1	1.6	4.3
1/2"	2.8	2	5.5
9/16"	3.5	2.6	7
5/8"	4.3	3.2	8.6
3/4"	6.2	4.5	12
7/8"	8.3	6.1	17
1"	11	8	22

Rated capacities shown are in US Tons (2,000 lb)

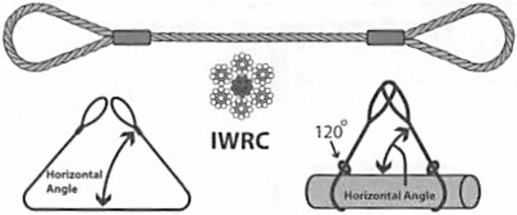
Rated capacities are based on:

1) Basket hitches with a D/d ratio of 25/1 or greater
2) Basket hitches with vertical legs (within 5°)
3) Choker hitch, angle of choke used = 120° or greater
4) Shackle diameter no smaller than the sling diameter
   a) applies to the bare eye of the sling
   b) does not apply to sling eyes with thimbles

These capacity tables contain typical capacity values based on ASME B30.9 standards and are for reference only. The manufacturers sling tag must be used to obtain the actual capacity of the equipment being used, since these values may vary from the actual capacity shown on the tag.

EEIPS - MS

6x19 and 6x36 class
1-part wire rope sling



Basket			2-Chokers	
60°	**30°**	***SIZE***	**60°**	**30°**
1.2	0.71	**1/4"**	0.9	0.52
1.9	1.1	**5/16"**	1.4	0.81
2.7	1.6	**3/8"**	2	1.2
3.7	2.1	**7/16"**	2.7	1.6
4.8	2.8	**1/2"**	3.5	2
6.1	3.5	**9/16"**	4.5	2.6
7.5	4.3	**5/8"**	5.5	3.2
11	6.2	**3/4"**	7.9	4.5
14	8.3	**7/8"**	11	6.1
19	11	**1"**	14	8

Rated capacities shown are in US Tons (2,000 lb)

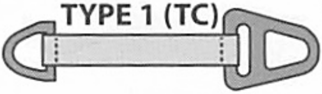
Rated capacities are based on:

1) Basket hitches with a D/d ratio of 25/1 or greater
2) Basket hitches with vertical legs (within 5°)
3) Choker hitch, angle of choke used = 120° or greater
4) Shackle diameter no smaller than the sling diameter
   a) applies to the bare eye of the sling
   b) does not apply to sling eyes with thimbles

These capacity tables contain typical capacity values based on ASME B30.9 standards and are for reference only. The manufacturers sling tag must be used to obtain the actual capacity of the equipment being used, since these values may vary from the actual capacity shown on the tag.

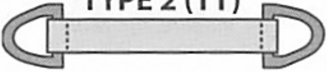
Web Sling Types

TYPE 1 (TC)



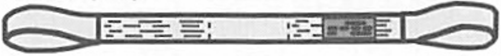
Have metal fitting on ends. Commonly used in a choker hitch, also rated for basket and vertical hitches

TYPE 2 (TT)



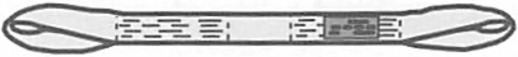
Normally rated for basket hitch, CANNOT be used in a choker hitch.

TYPE 3 (EE)



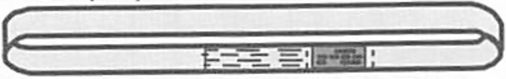
Flat Eye slings are very popular slings that can be used in all three types of hitches.

TYPE 4 (EE)



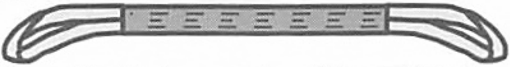
Twisted Eye slings form a better choker hitch.

TYPE 5 (EN)



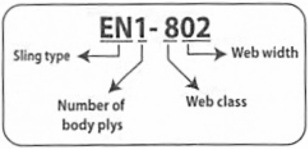
Endless slings can be used in all three types of hitches

TYPE 6 (RE)



Reversed Eye slings have protective webbing over the body

There is no standard method of identifying web slings, however most web slings contain markings similar to the example on the right



Graphics ©2012 Jerry Klinke

WEB slings - Overview

- Temperature -

1. ASME B30.9 states:
   Polyester and nylon slings cannot be used in contact with an object or at temperatures in excess of **194°F** (90°C) or below −40°F (−40°C).
2. OSHA 1910.184 states:
   Synthetic web slings of polyester and nylon shall not be used at temperatures in excess of **180 °F**
   Polypropylene shall not be used at temperatures in excess of 200 °F

- Chemically Active Environments -

1. ASME B30.9 states:
   The strength of synthetic webbing slings can be degraded by chemically active environments. This includes exposure to chemicals in the form of solids, liquids, gases, vapors, or fumes.
2. ASME B30.9 states:
   The strength of synthetic webbing slings is degraded by (excessive) exposure to sunlight or ultraviolet light.
3. OSHA 1910.184 states:
   Nylon web slings shall not be used where fumes, vapors, sprays, mists or liquids of acids or phenolics are present.
   Polyester and polypropylene web slings shall not be used where fumes, vapors, sprays, mists or liquids of caustics are present.

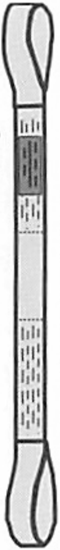
- Rigging Practices -

1. Slings shall not be shortened or lengthened by knotting, twisting, or by any unapproved methods.
2. Slings in contact with edges, corners, or protrusions should be protected with a material of sufficient strength, thickness, and construction to prevent damage to the sling.
3. Loads should not be rested on the sling, or be pulled from under a load when the load is resting on the sling
4. In a choker hitch, the choke point should only be on the sling body, not on a load-bearing splice or fitting.
5. An object in the eye of a sling should not be wider than 1/3 the length of the eye
6. Slings should not be constricted, bunched, or pinched by the load, hook, or any fitting.
7. Twisting of the sling shall be avoided

1-ply

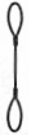
WEB SLINGS EE

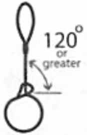
Working Load Limits

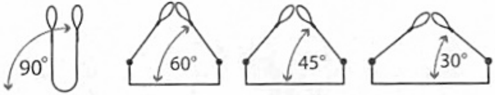


LIGHT DUTY

EE1-6xx







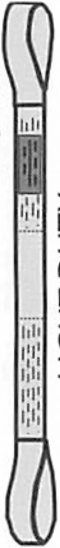
1-ply, Class 5, EE light duty	**Vertical**	**Choker**	**2-Leg or Basket** 90°	60°	45°	30°
1"	1,100	880	2,200	1,900	1,600	1,100
1 ½"	1,600	1,280	3,200	2,800	2,300	1,600
1 ¾"	1,900	1,520	3,800	3,300	2,700	1,900
2"	2,200	1,760	4,400	3,800	3,100	2,200
3"	3,300	2,640	6,600	5,700	4,700	3,300
4"	4,400	3,520	8,800	7,600	6,200	4,400
5"	5,500	4,400	11,000	9,500	7,800	5,500
6"	6,600	5,280	13,200	11,400	9,300	6,600

ASME B30.9-2003 data; manufacturer codes might be EE1-6xx (xx = width)

Graphics ©2012 Jerry Klinke

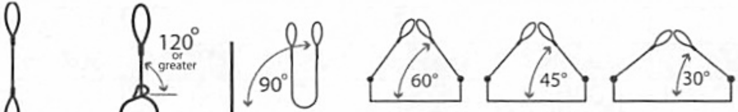
WEB SLINGS EE

Working Load Limits



LIGHT DUTY

EE2-6xx



2-ply, Class 5, EE light duty	Vertical	Choker	2-Leg or Basket 90°	60°	45°	30°
1"	2,200	1,760	4,400	3,800	3,100	2,200
1 ½"	3,300	2,640	6,600	5,700	4,700	3,300
1 ¾"	3,800	3,040	7,600	6,600	5,400	3,800
2"	4,400	3,520	8,800	7,600	6,200	4,400
3"	6,600	5,280	13,200	11,400	9,300	6,600
4"	8,200	6,560	16,400	14,200	11,600	8,200
5"	10,200	8,160	20,400	17,700	14,400	10,200
6"	12,300	9,840	24,600	21,300	17,400	12,300

ASME B30.9-2003 data; manufacturer codes might be EE2-6xx (xx = width)

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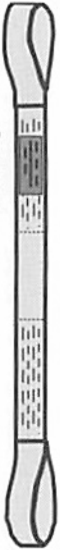
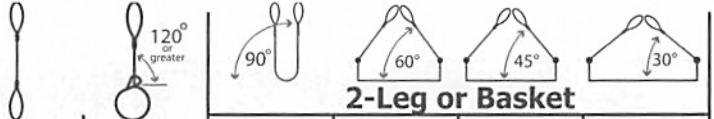
WEB SLINGS EE

1-ply

Working Load Limits



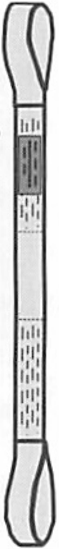


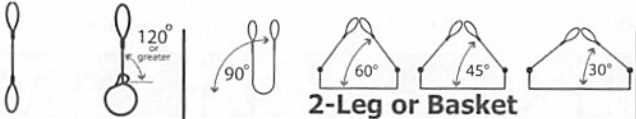
EE1-9xx **1-ply, Class 7, EE Heavy duty**	**Vertical**	**Choker**	**2-Leg or Basket**			
			90°	**60°**	**45°**	**30°**
1"	1,600	1,280	3,200	2,800	2,300	1,600
1 ½"	2,300	1,840	4,600	4,000	3,300	2,300
1 ¾"	2,700	2,160	5,400	4,700	3,800	2,700
2"	3,100	2,480	,6200	5,400	4,400	3,100
3"	4,700	3,760	9,400	8,100	6,600	4,700
4"	6,200	4,960	12,400	10,700	8,800	6,200
5"	7,800	6,240	15,600	13,500	11,000	7,800
6"	9,300	7,440	18,600	16,100	13,200	9,300
8"	11,750	9,400	21,150	18,300	15,000	11,750
10"	14,700	11,760	26,450	22,900	18,700	14,700
12"	17,650	14,120	31,750	27,500	22,400	17,650

Graphics ©2012 Jerry Klinke

WEB SLINGS EE

Working Load Limits





EE2-9xx

HEAVY DUTY

2-ply, Class 7 EE Heavy duty	Vertical	Choker	2-Leg or Basket 90°	60°	45°	30°
1"	3,100	2,480	6,200	5,400	4,400	3,100
1 ½"	4,700	3,760	9,400	8,100	6,600	4,700
1 ¾"	5,400	4,320	10,800	9,400	7,600	5,400
2"	6,200	4,960	12,400	10,700	8,800	6,200
3"	8,800	7,040	17,600	15,200	12,400	8,800
4"	11,000	8,800	22,000	19,100	15,600	11,000
5"	13,700	10,960	27,400	23,700	19,400	13,700
6"	16,500	13,200	33,000	28,600	23,000	16,500
8"	22,750	18,200	42,350	36,700	29,900	22,750
10"	28,400	22,720	52,900	45,800	37,400	28,400
12"	34,100	27,280	63,500	55,000	44,900	34,100

ASME B30.9-2003 data; manufacturer codes might be EE2-8xx or EE2-9xx (xx = width)

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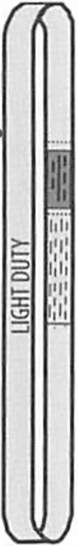
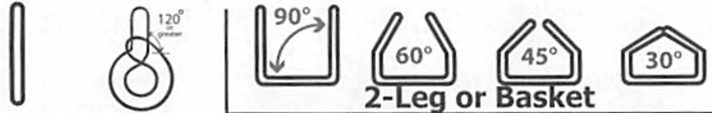
WEB SLINGS EN

1-ply

Working Load Limits



EN1-60x



1-ply, Class 5, EN light duty	Vertical	Choker	2-Leg or Basket			
			90°	60°	45°	30°
1"	2,200	1,760	4,400	3,800	3,100	2,200
1 ½"	3,200	2,560	6,400	5,550	4,530	3,200
1 ¾"	3,800	3,040	7,600	6,600	5,400	3,800
2"	4,400	3,520	8,800	7,600	6,200	4,400
3"	6,600	5,280	13,200	11,400	9,300	6,600
4"	8,800	7,040	17,600	15,280	12,480	8,800
5"	11,000	8,800	22,000	19,100	15,600	11,000
6"	13,200	10,560	26,400	22,920	18,720	13,200

ASME B30.9-2003 VRC data, other hitch capacities were calculated

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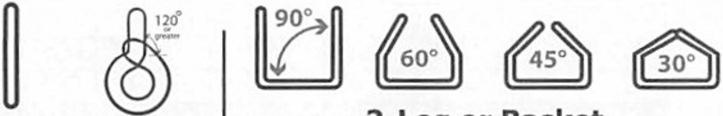
WEB SLINGS EN

Working Load Limits

2-ply

EN2-60x



2-ply, Class 5, EN light duty	Vertical	Choker	2-Leg or Basket			
			90°	**60°**	**45°**	**30°**
1"	4,400	3,520	8,800	7,600	6,200	4,400
1 ½"	6,600	5,280	13,200	11,400	9,300	6,600
1 ¾"	7,600	6,080	15,200	13,000	10,000	7,600
2"	8,800	7,040	17,600	15,280	12,480	8,800
3"	13,200	10,560	26,400	22,920	18,720	13,200
4"	16,400	13,120	32,800	28,400	23,200	16,400
5"	20,400	16,320	40,800	35,400	28,900	20,400
6"	24,600	19,680	49,200	42,700	34,880	24,600

ASME B30.9-2003 VRC data, other hitch capacities were calculated

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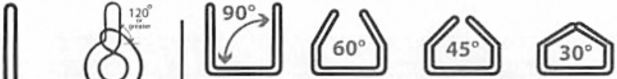
WEB SLINGS EN

1-ply

Working Load Limits



EN1-9xx 1-ply, Class 7, EN Heavy duty	Vertical	Choker	2-Leg or Basket			
			90°	60°	45°	30°
1"	3,200	2,560	6,400	5,550	4,530	3,200
1 ½"	4,600	3,680	9,200	7,987	6,524	4,600
1 ¾"	5,400	4,320	10,800	9,376	7,658	5,400
2"	6,200	4,960	12,400	19,100	15,600	11,000
3"	9,400	7,520	18,800	16,322	13,331	9,400
4"	12,400	9,920	24,800	21,531	17,585	12,400
5"	15,600	12,480	31,200	27,087	22,124	15,600
6"	18,600	14,880	37,200	32,296	26,378	18,600
8"	21,150	16,920	42,300	36,724	29,995	21,150
10"	26,450	21,160	52,900	45,927	37,511	26,450
12"	31,750	25,400	63,500	55,130	45,027	31,750

ASME B30.9-2003 VRC data, other hitch capacities were calculated

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WEB SLINGS EN

2-ply

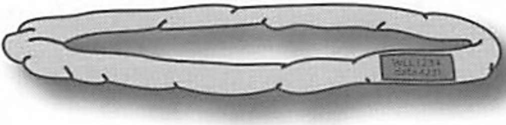
Working Load Limits

EN2-9xx 2-ply, Class 7 EN Heavy duty	Vertical	Choker	2-Leg or Basket			
			90°	**60°**	**45°**	**30°**
1"	6,200	4,960	12,400	10,765	8,793	6,200
1 ½"	9,400	7,520	18,800	16,322	13,331	9,400
1 ¾"	10,800	8,640	21,600	18,753	15,316	10,800
2"	12,400	9,920	24,800	21,531	17,585	12,400
3"	17,600	14,080	35,200	30,560	24,960	17,600
4"	22,000	17,600	44,000	38,200	31,200	22,000
5"	27,400	21,920	54,800	47,576	38,858	27,400
6"	33,000	26,400	66,000	57,300	46,800	33,000
8"	42,350	33,880	84,700	73,535	60,060	42,350
10"	52,900	42,320	105,800	91,854	75,022	52,900
12"	63,500	50,800	127,000	110,259	90,055	63,500

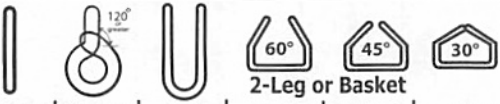
ASME B30.9-2003 VRC data, other hitch capacities were calculated

Graphics ©2012 Jerry Klinke

Roundslings



Working Load Limits in US lbs

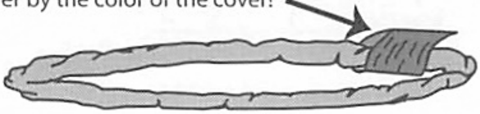


		2-Leg or Basket			
Vertical	**Choker**	**90°**	**60°**	**45°**	**30°**
2,600	2,100	5,200	4,500	3,700	2,600
5,300	4,200	10,600	9,200	7,500	5,300
8,400	6,700	16,800	14,500	11,900	8,400
10,600	8,500	21,200	18,400	15,000	10,600
13,200	10,600	26,400	22,900	18,700	13,200
16,800	13,400	33,600	29,100	23,800	16,800
21,200	17,000	42,400	36,700	30,000	21,200
25,000	20,000	50,000	43,300	35,400	25,000
31,000	24,800	62,000	53,700	43,800	31,000
40,000	32,000	80,000	69,300	56,600	40,000
53,000	42,400	106,000	91,800	74,900	53,000
66,000	52,800	132,000	114,300	93,300	66,000
90,000	72,000	180,000	155,900	127,300	90,000

WSTDA & ASME minimum values - Manufacturers may have different WLL's

ASME B30.9 WSTDA-RS-2 (2005)

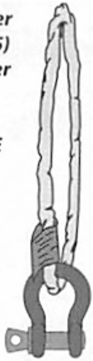
Color guidelines for polyester roundsling covers are widely used to indicate the vertical rated load of roundslings; **however, this is not followed by some manufacturers.** Always select and use roundslings by the rated load as shown on the sling identification; never by the color of the cover!

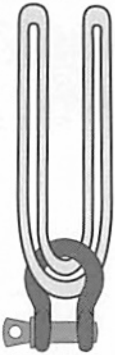


Graphics ©2012 Jerry Klinke

Roundslings

Stock Diameters per WSTDA-RS-2 (2005) for Vertical / Choker Hitches and incorporated by reference in ASME B30.9 - 2010





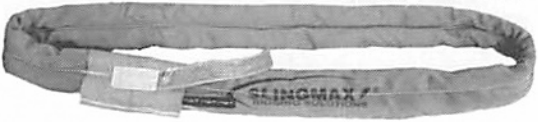
Vertical Rated Capacity	Vertical	Basket
	MINIMUM Shackle Size required	
2,600	**1/2"**	**5/8"**
5,300	**5/8"**	**7/8"**
8,400	**3/4"**	**1"**
10,600	**7/8"**	**1- 1/4"**
13,200	**1"**	**1- 3/8"**
16,800	**1- 1/8"**	**1- 5/8"**
21,200	**1- 1/4"**	**1- 3/4"**
25,000	**1- 1/4"**	**1- 7/8"**
31,000	**1- 1/2"**	**2"**
40,000	**1- 5/8"**	**2- 3/8"**
53,000	**1- 7/8"**	**2- 3/4"**
66,000	**2- 1/8"**	**3"**
90,000	**2- 1/2"**	**3- 1/2"**

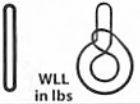
Shackle diameters smaller than these may reduce the rated load of the sling.

Graphics ©2012 Jerry Klinke

Twin-Path® Slings

Working Load Limits





WLL in lbs

Twin-Path® P/N (1)	Vertical	Choker	Body Width
TPXC 1000	10,000	8,000	3″
TPXC 1500	15,000	12,000	3″
TPXC 2000	20,000	16,000	3″
TPXC 2500	25,000	20,000	4″
TPXC 3000	30,000	24,000	4″
TPXC 4000	40,000	32,000	5″
TPXC 5000	50,000	40,000	5″
TPXC 6000	60,000	48,000	5″
TPXC 7000	70,000	56,000	6″
TPXC 8500	85,000	68,000	6″
TPXC 10000	100,000	80,000	6″
TPXC 12500	125,000	100,000	8″
TPXC 15000	150,000	120,000	8″
TPXC 17500	175,000	140,000	10″
TPXC 20000	200,000	160,000	10″
TPXC 25000	250,000	200,000	11″
TPXC 27500	275,000	220,000	11″
TPXC 30000	300,000	240,000	13″
TPXC 40000	400,000	320,000	14″
TPXC 50000	500,000	400,000	16″

(1) Stock Number are for slings with a Covermax™ Cover

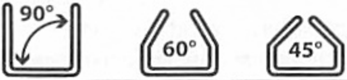
Data for the TWIN-PATH® EXTRA SLING WITH COVERMAX® and K-SPEC® Core Yarn TPXC has been provided by: SLINGMAX® Rigging Solutions (www.slingmax.com) Telephone: 610-485-8500

Twin-Path® Slings

Working Load Limits

SLINGMAX
RIGGING SOLUTIONS

Basket Hitches - WLL in lbs



Twin-Path® P/N (1)	90 deg	60 deg	45 deg
TPXC 1000	20,000	17,320	14,140
TPXC 1500	30,000	25,980	21,210
TPXC 2000	40,000	34,640	28,280
TPXC 2500	50,000	43,300	35,350
TPXC 3000	60,000	51,960	42,420
TPXC 4000	80,000	69,280	56,560
TPXC 5000	100,000	86,139	70,700
TPXC 6000	120,000	103,920	84,840
TPXC 7000	140,000	121,240	98,980
TPXC 8500	170,000	147,220	120,190
TPXC 10000	200,000	173,200	141,400
TPXC 12500	250,000	216,500	176,750
TPXC 15000	300,000	259,800	212,100
TPXC 17500	350,000	303,100	247,450
TPXC 20000	400,000	346,400	282,800
TPXC 25000	500,000	433,000	353,500
TPXC 27500	550,000	476,300	388,850
TPXC 30000	600,000	519,600	424,200
TPXC 40000	800,000	689,112	565,600
TPXC 50000	1,000,000	861,390	707,000

(1) Stock Number are for slings with a Covermax™ Cover

Data for the TWIN-PATH® EXTRA SLING WITH COVERMAX® and K-SPEC® Core Yarn TPXC has been provided by: SLINGMAX® Rigging Solutions (www.slingmax.com) Telephone: 610-485-8500

Twin-Path® Slings

Q: What are the Pin or hardware diameters required with a Twin-Path® Sling?

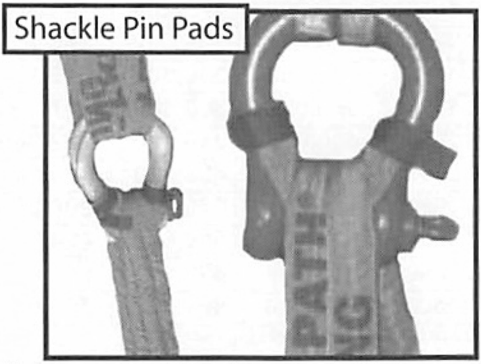
A: Slings used with fittings shall be compatible with the fittings used. The lifting capacity shall be rated at the lower of the sling or fitting. Fitting openings shall be of the proper shape and size to assure that the sling will seat properly.

Q: What happens if oil or gasoline gets on my Twin-Path® Sling?

A: Hydrocarbons and oils do not affect the performance of any Twin-Path® sling.

Q: How much stretch with a Twin-Path® Sling?

A: Twin-Path® Extra Slings w/ K-Spec® core yarn stretch less than 1% at rated capacity.



Shackle Pin Pads

If you must rig a synthetic sling on the shackle pin, protect it with a Shackle Pin Pad.

Graphics ©2012 Jerry Klinke

Comparisons

Here are some typical prices for different types of slings. They have been grouped as close to the same rated capacity and length as possible. Prices were obtained in June 2012 and represent a typical cost.

SLING	Size	VRC	Price
Chain sling	9/32"	3500 lbs	$ 360.00
Wire Rope	3/8"	2800 lbs	$ 32.00
Web sling	1" wide	2400 lbs	$ 26.00
Roundsling	N/A	2600 lbs	$ 25.00
Mesh Sling	2" wide	2300 lbs	$ 460.00

Note: All slings are 4 feet in length

TwinPath® Slings

Size (weight)	VRC	**Price**
TPXC 1000 (8 lbs)	10,000 lbs	$ 700.00
TPXC 3000 (14 lbs)	30,000 lbs	$ 1,688.00

Wire Rope Slings

Size (weight)	VRC	**Price**
3/4" dia (26 lbs)	11,200 lbs	$ 130.00
1-1/4" dia (83 lbs)	30,000 lbs	$ 450.00

Note: All slings are 20 feet in length

VRC = Vertical Rated Capacity

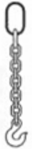
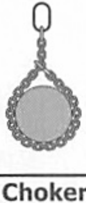
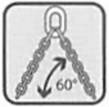
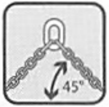
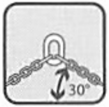
	Design factor
Chain sling	4:1
Wire Rope	5:1
Web sling	5:1
Roundsling	5:1
Mesh Sling	5:1
TwinPath® Sling	5:1

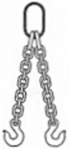
Graphics ©2012 Jerry Klinke

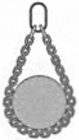
CHAIN SLINGS

Working Load Limits

Grade 80 Alloy

Grade 80 Alloy Steel Chain Slings					
			2-Leg or Basket		
SIZE	**Vertical**	**Choker**	**60°**	**45°**	**30°**
7/32" (5.5 mm)	2,100	1,700	3,600	3,000	2,100
9/32" (7 mm)	3,500	2,800	6,100	4,900	3,500
5/16" (8 mm)	4,500	3,600	7,800	6,400	4,500
3/8" (10 mm)	7,100	5,700	12,300	10,000	7,100
1/2" (13 mm)	12,000	9,600	20,800	17,000	12,000
5/8" (16 mm)	18,100	14,500	31,300	25,600	18,100
3/4" (20 mm)	28,300	22,600	49,000	40,000	28,300
7/8" (22 mm)	34,200	27,400	59,200	48,400	34,200
1" (26 mm)	47,700	38,200	82,600	67,400	47,700
1-1/4" (32 mm)	72,300	57,800	125,200	102,200	72,300





D/d value is 6:1 without reduction of capacity

National Association of Chain Manufacturers (NACM) 2011

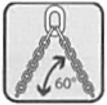
To be included in the 2013 revision of ASME B30.9

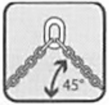
Graphics ©2012 Jerry Klinke

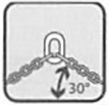
CHAIN SLINGS

Working Load Limits

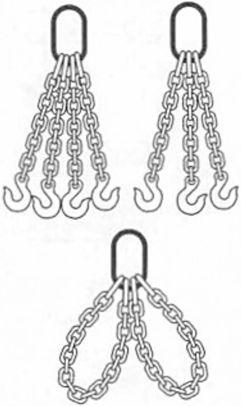
Grade 80 Alloy







Grade 80 Alloy Steel Chain Slings	3 or 4 Leg Bridle Sling Double Basket Sling		
SIZE	60°	45°	30°
7/32" (5.5 mm)	5,500	4,400	3,200
9/32" (7 mm)	9,100	7,400	5,200
5/16" (8 mm)	11,700	9,500	6,800
3/8" (10 mm)	18,400	15,100	10,600
1/2" (13 mm)	31,200	25,500	18,000
5/8" (16 mm)	47,000	38,400	27,100
3/4" (20 mm)	73,500	60,000	42,400
7/8" (22 mm)	88,900	72,500	51,300
1" (26 mm)	123,900	101,200	71,500
1-1/4" (32 mm)	187,800	153,400	108,400



D/d value is 6:1 without reduction of capacity

National Association of Chain Manufacturers (NACM) 2011

To be included in the 2013 revision of ASME B30.9

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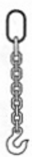
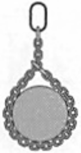
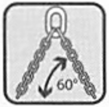
CHAIN SLINGS

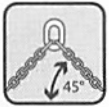
Working Load Limits

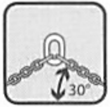
Grade 100 Alloy

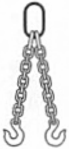


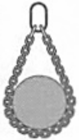












Grade 100 Alloy Steel Chain Slings			2-Leg or Basket		
SIZE	Vertical	Choker	60°	45°	30°
7/32" (5.5 mm)	2,700	2,100	4,700	3,800	2,700
9/32" (7 mm)	4,300	3,500	7,400	6,100	4,300
5/16" (8 mm)	5,700	4,500	9,900	8,100	5,700
3/8" (10 mm)	8,800	7,100	15,200	12,400	8,800
1/2" (13 mm)	15,000	12,000	26,000	21,200	15,000
5/8" (16 mm)	22,600	18,100	39,100	32,000	22,600
3/4" (20 mm)	35,300	28,300	61,100	49,900	35,300
7/8" (22 mm)	42,700	34,200	74,000	60,400	42,700

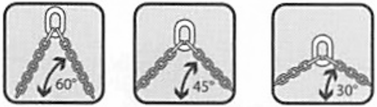
D/d value is 6:1 without reduction of capacity
National Association of Chain Manufacturers (NACM) 2011
To be included in the 2013 revision of ASME B30.9

Graphics ©2012 Jerry Klinke

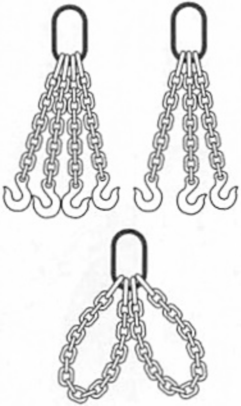
CHAIN SLINGS

Working Load Limits

Grade 100 Alloy



Grade 100 Alloy Steel Chain Slings	3 or 4 Leg Bridle Sling Double Basket Sling		
SIZE	**60°**	**45°**	**30°**
7/32" (5.5 mm)	7,000	5,700	4,000
9/32" (7 mm)	11,200	9,100	6,400
5/16" (8 mm)	14,800	12,100	8,500
3/8" (10 mm)	22,900	18,700	13,200
1/2" (13 mm)	39,000	31,800	22,500
5/8" (16 mm)	58,700	47,900	33,900
3/4" (20 mm)	91,700	74,900	53,000
7/8" (22 mm)	110,900	90,600	64,000



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D/d value is 6:1 without reduction of capacity

National Association of Chain Manufacturers (NACM) 2011

To be included in the 2013 revision of ASME B30.9

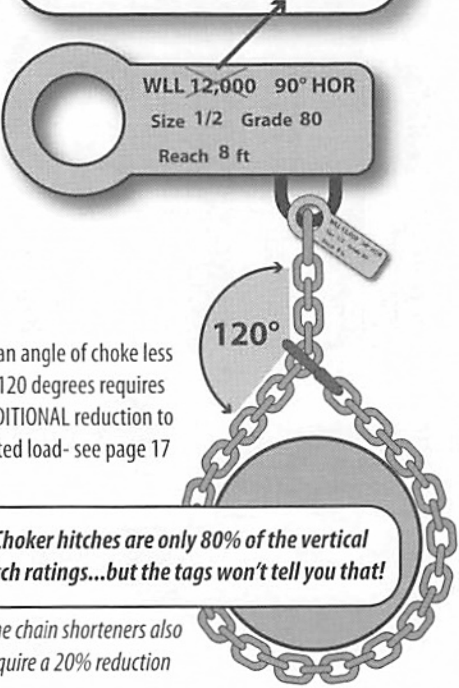
Chain Slings and Chokers

Operating Practices

Alloy Chain Slings require an 20% reduction when used in a choker hitch

Multiply the vertical hitch rating by .80 and you will determine what the reducted rating is...

12000 x .80 = 9600
Reduced rating: 9,600 lbs



Using an angle of choke less than 120 degrees requires an ADDITIONAL reduction to the rated load- see page 17

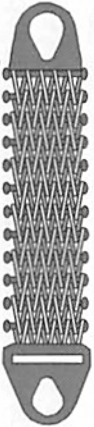
Choker hitches are only 80% of the vertical hitch ratings...but the tags won't tell you that!

some chain shorteners also require a 20% reduction

Graphics ©2012 Jerry Klinke

MESH SLINGS

Working Load Limits



Rated Capacities (in lbs)

Sling Width	10 Gage Heavy		12 Gage Medium		14 gage Light	
	Vertical or Choker	Basket w/vertical legs	Vertical or Choker	Basket w/vertical legs	Vertical or Choker	Basket w/vertical legs
2"	1,500	3,000	1,350	2,700	900	1,800
3"	2,700	5,400	2,000	4,000	1,400	2,800
4"	4,000	8,000	2,700	5,400	2,000	4,000
6"	6,000	12,000	4,500	9,000	3,000	6,000
8"	8,000	16,000	6,000	12,000	4,000	8,000
10"	10,000	20,000	7,500	15,000	5,000	10,000
12"	12,000	24,000	9,000	18,000	6,000	12,000
14"	14,000	28,000	10,500	21,000	7,000	14,000
16"	16,000	32,000	12,000	24,000	8,000	16,000
18"	18,000	36,000	13,500	27,000	9,000	18,000
20"	20,000	40,000	15,000	30,000	10,000	20,000

Rated loads (capacities) shown are based on OSHA tables

Metal mesh slings are widely used in metalworking and in other industries where loads are abrasive, hot, or will tend to cut web slings. Unlike nylon and wire rope slings, metal mesh slings resist abrasion and cutting. Metal mesh slings grip the load firmly without extensive stretching, easily maintaining balanced loads. Uncoated metal mesh slings withstand temperatures up to 550 degrees F (288 degrees C).

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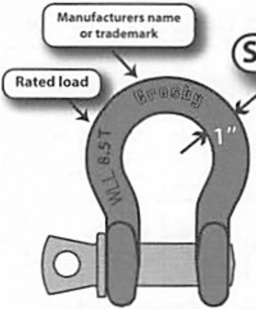
Shackles

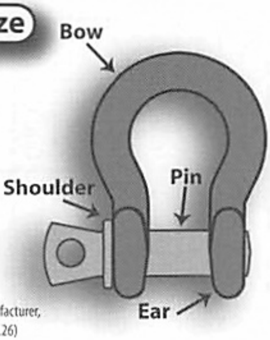
Nomenclature

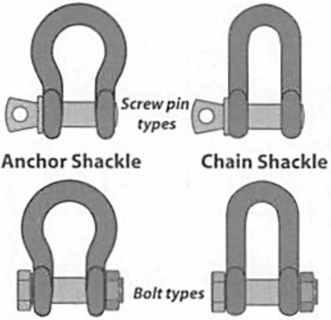
Shackle sizes are based on the diameter of the BOW and NOT the pin diameter!


Manufacturers name or trademark
Size
Rated load
Crosby
WLL 8.5T
1"

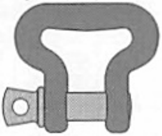
Shackle Identification

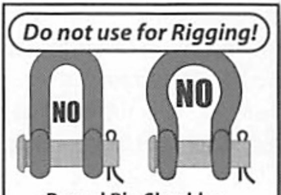
The shackle pin should also have the name of the manufacturer, the grade, material type, or load rating (ASME B30.26)


Bow
Shoulder
Pin
Ear


Screw pin types
Anchor Shackle
Chain Shackle
Bolt types

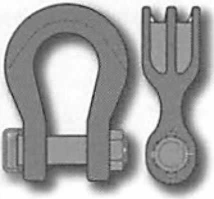
Synthetic Sling Shackle




Do not use for Rigging!
NO
NO

Round Pin Shackles

"Wide Body" shackle



Graphics ©2012 Jerry Klinke

Shackles

Shackle capacities vary by each manufacturer

The examples below are for 1" shackles, but with 5 different capacities.

3 ton

Various manufacturers

316 Stainless Steel

8.5 ton

Typical of: Crosby, CM, Chicago, and others.

Carbon Steel

10 ton

Exclusive to:
Columbus McKinnon
"Super Strong Shackle"

Advanced microalloy

12.5 ton

Typical of: Crosby, CM, Chicago, and others.

Forged Alloy

16 ton

Exclusive to:
Skookum

Skookum #263

Crosby = The Crosby Group - www.thecrosbygroup.com
CM = Columbus McKinnon - www.cmworks.com
Chicago Hardware - www.chicagohardware.com
Skookum - www.ulvencompanies.com

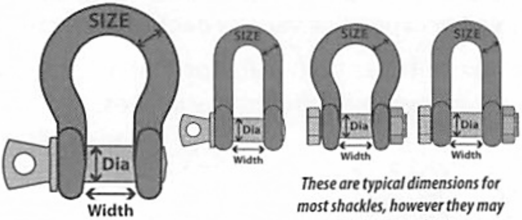
The tables in this book are only intended to provide typical hardware capacities for pre-job planning activities.

Always use the capacity shown on the shackle, never rely on tables alone.

Graphics ©2012 Jerry Klinke

Shackles

Typical Dimensions

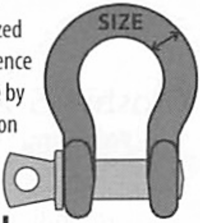


These are typical dimensions for most shackles, however they may vary with manufacturers.

		SIZE			
Width (in)	Pin dia (in)	Body dia (in)	Body dia (mm)	Width (mm)	Pin dia (mm)
0.38″	0.25″	3/16″	4.85	9.65	6.35
0.47″	0.31″	1/4″	6.35	11.9	7.85
0.53″	0.38″	5/16″	7.85	13.5	9.65
0.66″	0.44″	3/8″	9.65	16.8	11.2
0.75″	0.50″	7/16″	11.2	19.1	12.7
0.81″	0.63″	1/2″	12.7	20.6	16
1.06″	0.75″	5/8″	17.5	26.9	19.1
1.25″	0.88″	3/4″	20.6	31.8	22.4
1.44″	1.00″	7/8″	24.6	36.6	25.4
1.69″	1.13″	1″	26.9	42.9	28.7
1.81″	1.25″	1-1/8″	37.8	46	31.8
2.03″	1.38″	1-1/4″	35.1	51.5	35.1
2.25″	1.5″	1-3/8″	38.1	57	38.1
2.38″	1.63″	1-1/2″	41.1	60.5	41.4
2.88″	2.00″	1-3/4″	57	73	51
3.25″	2.25″	2″	61	82.5	57
4.13″	2.75″	2-1/2″	79.5	105	70

Shackles Typical Capacities

Shackle capacities will vary between manufacturers - this table is a summarized comparison that should be used for reference only. ALWAYS select and use the shackle by the rated capacity (WLL) that is shown on the shackle.



SIZE	Carbon Steel See note 1	CM® Super Strong Carbon Steel See note 2	Forged ALLOY Crosby®/CM® See note 3	
	WLL tons	WLL tons	WLL tons	
3/16″	0.3	0.5		
1/4″	0.5	0.75		
5/16″	0.75	1		
3/8″	1	1.5	2	
7/16″	1.5	2	2.6	
1/2″	2	3	3.3	
5/8″	3.25	4.5	5	
3/4″	4.75	6.5	7	
7/8″	6.5	8.5	9.5	
1″	8.5	10	12.5	
1-1/8″	9.5	12	15	
1-1/4″	12	14	18	
1-3/8″	13.5	17	21	
1-1/2″	17	20	25 *(SP)*	30 *(BT)*
1-3/4″	25	30	34 *(SP)*	40 *(BT)*
2″	35	35	43 *(SP)*	55 *(C-BT)*
2-1/2″	55		85 *(SP)*	85 *(C-BT)*

note 1: *Catalog data from Crosby, CM (Columbus McKinnon) and Chicago Hardware*
note 2: *Special type shackle available only from CM (Columbus McKinnon)*
note 3: *Catalog data from Crosby and CM (Columbus McKinnon)*

(SP) = Screw Pin Type *(BT) = Bolt Type* *(C-BT) = CROSBY Bolt Type*

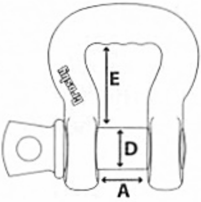
Anchor shackles manufactured by Crosby are rated in Metric tons - all others are rated in US tons

Shackles

For use with WEB and Roundslings

Crosby® S-253

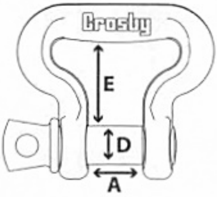
Web Sling Shackle



Web Size	Round sling Size	WLL (tons)	A	D	E
2"	# 2	3 1/2	1.06	0.75	1.62
3"	# 3	4 2/4	1.25	0.88	1.5
4"	# 4	6 1/2	1.44	1	2
6"	# 6	8 1/2	1.69	1.13	2.75

Crosby® S-281

Web Sling Shackle

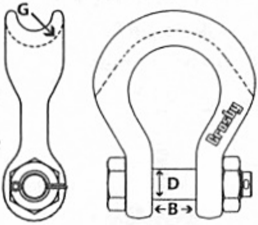


Web Size	Round sling Size	WLL (tons)	A	D	E
1'"	# 1 & 2	3 1/2	0.88	0.75	1.5
1-1/2"	# 3 & 4	6 2/4	1.25	0.88	1.88
2"	# 5 & 6	8 3/4	1.38	1	2.81
3"	# 7 & 8	12 1/2	1.62	1.25	3.06
4"	# 9 & 10	20 1/2	2.12	1.5	5.75
5"	# 11 & 12	35	2.5	2	6.34
6"	# 13	50	3	2.25	7.7

Shackles - Wide Body

Crosby® Wide Body Shackles G-2160

Can be used to connect HIGH STRENGTH Synthetic Web Slings, HIGH STRENGTH Synthetic Round Slings or Wire Rope Slings. Increase in shackle bow radius provides minimum 58% gain in sling bearing surface and eliminates need for a thimble.



All ratings are in metric tons, also embossed on side of shackle bow

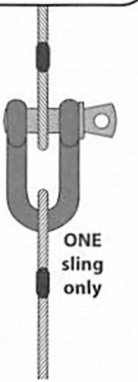
WLL$^{(t)}$	DIA*	B	D	G	(lbs) Weight
7	2.1	1.25	0.88	1.25	4
12.5	2.4	1.69	1.13	1.37	8.8
18	2.8	2.03	1.38	1.5	14.9
30	4.1	2.37	1.63	1.75	26.5
40	3.6	2.88	2	2.31	35
55	4.3	3.25	2.25	2.63	68
75	5.9	4.13	2.75	2.5	99
125	6.8	5.12	3.15	3.15	161
200	8.9	5.91	4.12	4.33	370
300	11.8	7.38	5.25	5.38	847
400	14.3	8.66	6.3	6.3	1130
500	14.8	9.84	7.09	6.69	1440
600	20.3	10.83	7.87	7.28	1995
700	16.6	11.81	8.46	7.87	2415
800	18	12.8	9.06	8.27	2880
900	22.4	13.78	9.84	8.66	3628
1000	19.3	14.96	10.63	9.06	4155
1250	24.4	16.93	11.81	10.43	5320
1550	27.3	18.31	12.6	15.92	8302

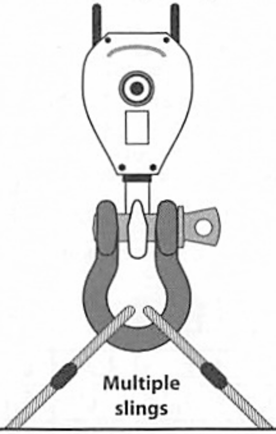
* DIA = Effective Body Diameter (as provided by Crosby 2010 catalog data)

Shackles

Operating Practices

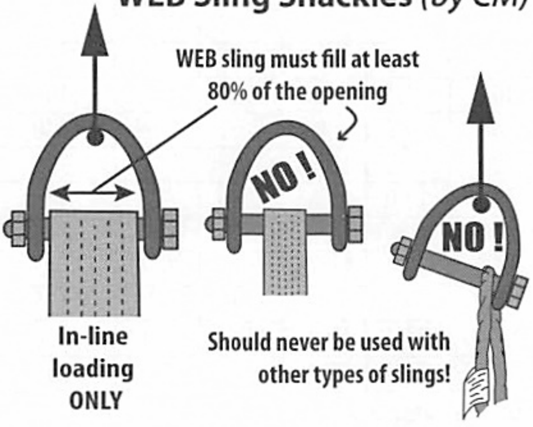
Chain shackles are designed for in-line tension ONLY





Anchor shackles are designed for multiple slings in the body of the shackle

WEB Sling Shackles *(by CM)*



WEB sling must fill at least 80% of the opening

In-line loading ONLY

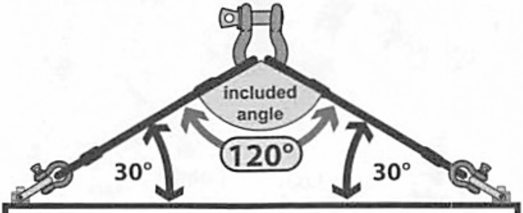
Should never be used with other types of slings!

Graphics ©2012 Jerry Klinke

Shackles

Operating Practices

Shackles
120° MAX
included angle

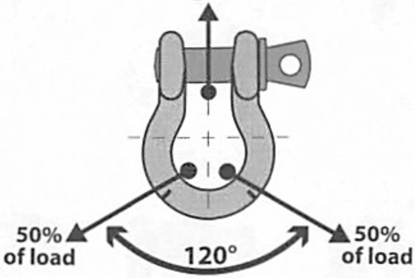

included angle
120°
30°
30°

"Multiple slings in the body of a shackle shall not exceed 120 degree included angle"

ASME B30.26

(30 degrees horizontal sling angles)

symmetrical loading example

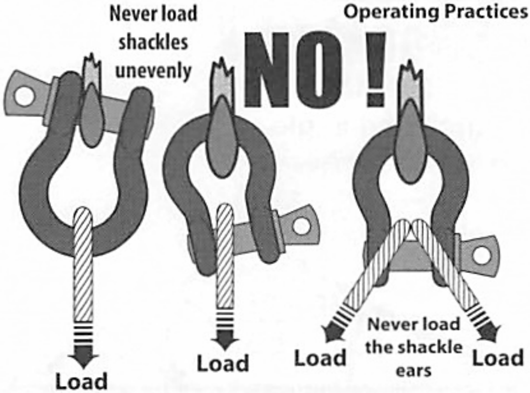

50% of load
120°
50% of load

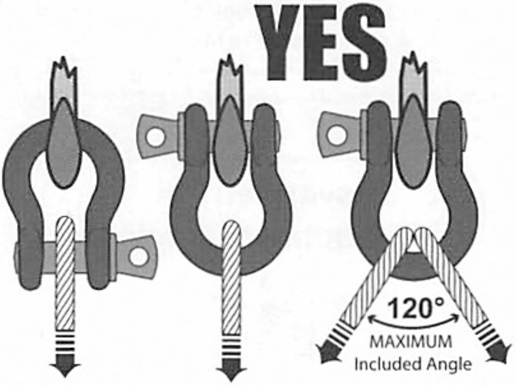
100% of rated capacity

Graphics ©2012 Jerry Klinke

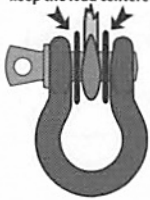
Shackles

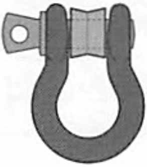
Operating Practices


Never load shackles unevenly
NO !
Load
Load
Load
Never load the shackle ears
Load


YES
120°
MAXIMUM
Included Angle

Washers can also be used to keep the load centered.





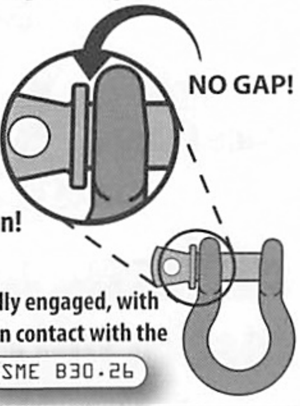
A manufactured "Spool" is designed to keep the load centered on the pin (Crosby # S-255)

Graphics ©2012 Jerry Klinke

Shackles

Operating Practices

How tight should you tighten a shackle pin ?



Hand tighten only!

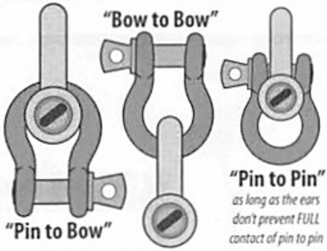
Don't back off the pin!

"The screw pin shall be fully engaged, with the shoulder (of the pin) in contact with the shackle body"

ASME B30.26

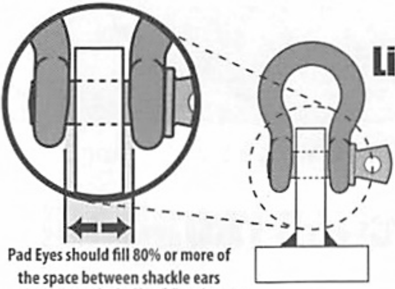
Point Loading of shackles:

"Point loading of Crosby® shackles is acceptable as long as the load is reasonably centered"


"Bow to Bow"
"Pin to Pin"
as long as the ears don't prevent FULL contact of pin to pin
"Pin to Bow"

Note: Point loading is not specifically addressed in OSHA or in the ASME B30.26 standards.

Pad Eyes Lifting Lugs



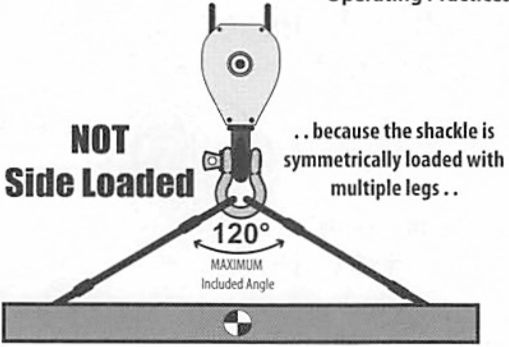
Pad Eyes should fill 80% or more of the space between shackle ears

. . . in order to use the shackle at full rated capacity . . . .

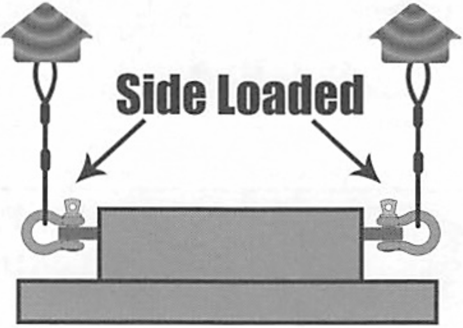
Graphics ©2012 Jerry Klinke

Shackles

Operating Practices


NOT
Side Loaded
. . because the shackle is symmetrically loaded with multiple legs . .
120°
MAXIMUM
Included Angle

Use at full capacity


Side Loaded

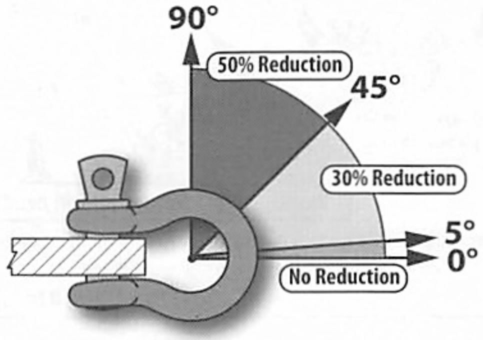
Side Loading is with a SINGLE sling . . .

Reduction required!

Graphics ©2012 Jerry Klinke

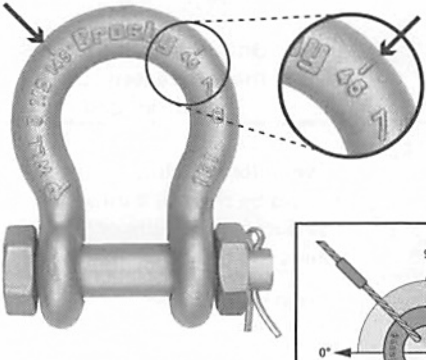
Shackle Side Loading

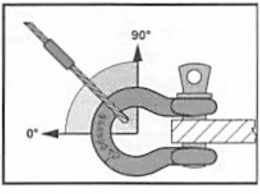
Operating Practices


90°
50% Reduction
45°
30% Reduction
5°
0°
No Reduction

"If the shackle is to be side loaded, the rated load shall be reduced according to the recommendations of the manufacturer or a qualified person" ASME B30.26

Only Crosby® shackles have degree indicators
. . . to help determine angles when side loaded

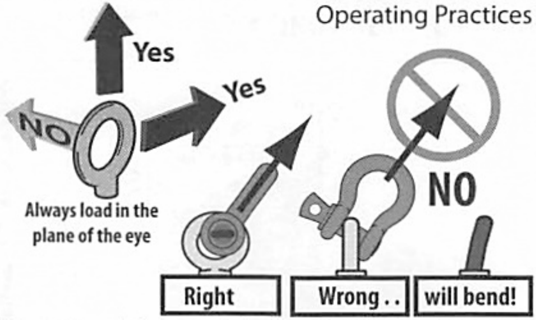




Graphics ©2012 Jerry Klinke

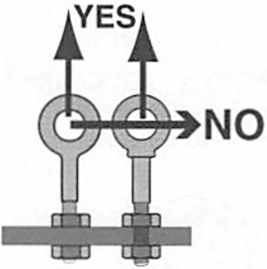
Eyebolts

Operating Practices

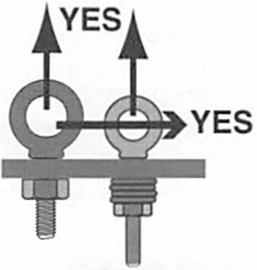

Yes
Yes
NO
Always load in the plane of the eye
NO
Right
Wrong . .
will bend!

"When using eyebolts for angular load handling, the plane of the eyebolts shall be aligned with the direction of pull"

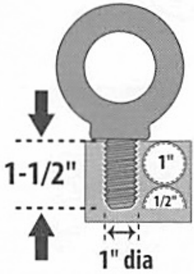
ASME B30.26-2010 Eyebolts



vertical pull only!



Only Shoulder Eyebolts that are seated - can be side loaded


1-1/2"
1"
1/2"
1" dia

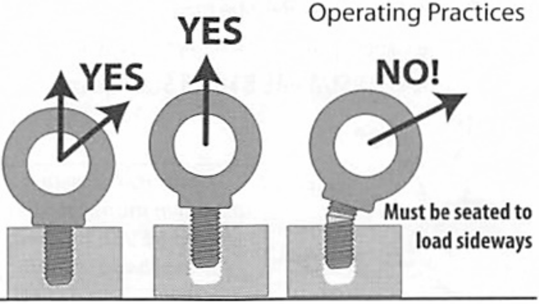
Eye bolts and Hoist Rings should be threaded into the surface a minimum of 1.5 times the thread diameter*

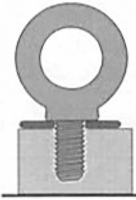
* per ASME B30.26-2.9.4.2 "when used in a tapped blind hole, the effective thread length shall be at least 1-1/2 times the diameter of the bolt for engagement in steel ... For other thread engagements or in other materials, contact the eyebolt manufacturer or a qualified person."

Graphics ©2012 Jerry Klinke

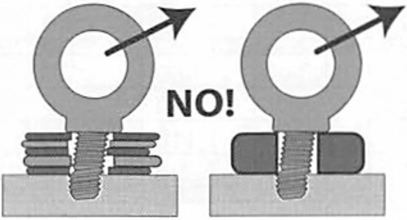
Eyebolts

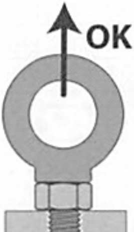
Operating Practices


YES
YES
NO!
Must be seated to load sideways

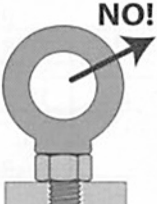


"Steel flat washers may be used under the shoulder to position the plane of the eye"
ASME B30.26-2010 Eyebolts (2.9.4.2)





Spacers, stacked washers and nuts should be avoided for angular loads

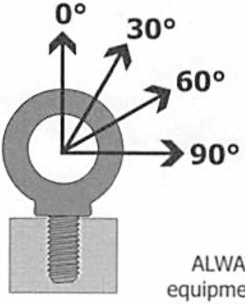


Graphics ©2012 Jerry Klinke

Eyebolts

Forged Alloy Shoulder Machinery Eyebolts

NOTE: These values are only valid for eyebolts manufactured to meet **ANSI/ASME B18.15 Standards**.



Eyebolts from an unknown manufacturer should NEVER be used for overhead lifting!

ALWAYS VERIFY WLL's with the equipment manufacturer before use.

SIZE	0°	30°	60°	90°
1/4"	400	75	NR	NR
5/16"	680	210	NR	NR
3/8"	1,000	400	220	180
7/16"	1,380	530	330	260
1/2"	1,840	850	520	440
9/16"	2,370	1,160	700	570
5/8"	2,940	1,410	890	740
3/4"	4,340	2,230	1,310	1,140
7/8"	6,000	2,960	1,910	1,630
1"	7,880	3,850	2,630	2,320
1-1/8"	9,920	4,790	3,840	3,390
1-1/4"	12,600	6,200	4,125	3,690
1-1/2"	18,260	9,010	6,040	5,460
1-3/4"	24,700	12,100	8,250	7,370
2"	32,500	15,970	10,910	9,740

WLL values shown in pounds

** ANSI/ASME B18.15-1985 (Reaffirmed 1995, 2003)*

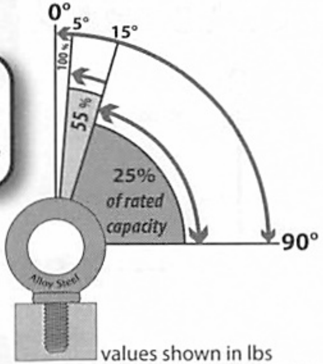
Graphics ©2012 Jerry Klinke

Eyebolts

Forged Alloy Shoulder Machinery Eyebolts

NOTE: These values are only valid for eyebolts manufactured to meet **ASME B30.26 Standards**.

IMPORTANT!
This page is only for eyebolts that are:
(1) Forged Alloy Material
(2) Shouldered Machinery type
(3) Conform to ASME B30.26



values shown in lbs

	0° *to* **5°**	**6°** *to* **15°**	**16°** *to* **90°**
	100% of capacity	*55% of capacity*	*25% of capacity*
SIZE *(diameter)*	***Capacity*** *or* ***Working Load Limit***		
1/4"	400	220	100
5/16"	680	374	170
3/8"	1,000	550	250
1/2"	1,840	1,012	460
5/8"	2,940	1,617	735
3/4"	4,340	2,387	1,085
7/8"	6,000	3,300	1,500
1"	7,880	4,334	1,970
1-1/4"	12,600	6,930	3,150
1-1/2"	18,260	10,043	4,565
1-3/4"	24,700	13,585	6,175
2"	32,500	17,875	8,125

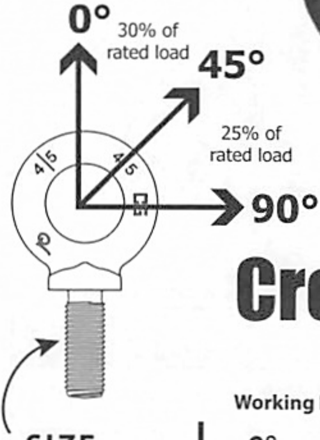
Eyebolts from an unknown manufacturers or with unknown material types should NEVER be used for overhead lifting!

Graphics ©2012 Jerry Klinke

Eyebolts

Forged Alloy Shoulder Machinery Eyebolts

These Working Load Limits are to ONLY be used with **Crosby® S-279 Forged Machinery Eyebolts!**



Crosby ®

S-279 UNC

Working Load Limit (lbs)

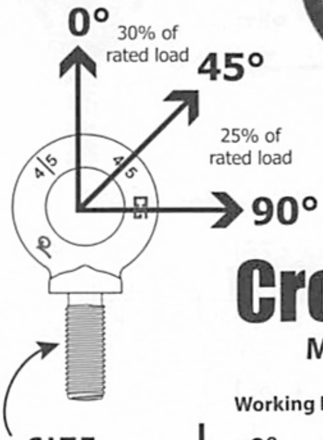
SIZE	0°	45°	90°
1/4 x 1	650	195	163
5/16 x 1-1/8	1200	360	300
3/8 x 1-1/4	1550	465	388
1/2 x 1-1/2	2600	780	650
5/8 x 1-3/4	5200	1560	1300
3/4 x 2	7200	2160	1800
7/8 x 2-1/4	10600	3180	2650
1 x 2-1/2	13300	3990	3325
1-1/4 x 3	21000	6300	5250
1-1/2 x 3-1/2	24000	7200	6000

Graphics ©2012 Jerry Klinke

Eyebolts

Forged Alloy Shoulder Machinery Eyebolts

These Working Load Limits are to ONLY be used with **Crosby® S-279 Forged Machinery Eyebolts!**



Crosby ®

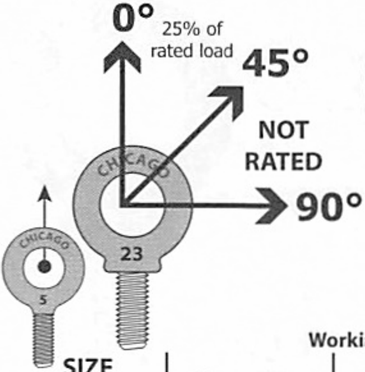
M-279 Metric

SIZE	Working Load Limit (kg) 0°	45°	90°
M6 x 1.0	200	60	50
M8 x 1.0	400	120	100
M10 x 1.5	640	192	160
M12 x 1.75	1000	300	250
M16 x 2.0	1800	540	450
M20 x 2.5	2500	750	625
M24 x 3.0	4000	1200	1000
M30 x 3.5	6000	1800	1500
M36 x 4.0	8500	2550	2125

Graphics ©2012 Jerry Klinke

Eyebolts

Eyebolts by Chicago Hardware



CHICAGO
USA
1/2
25

SIZE			Working Load Limit (lbs)	
Plain	Shoulder	Dia x TPI	0°	45°
1	21	1/4" x 20	500	125
2	22	5/16" x 18	900	225
3	23	3/8" x 16	1,400	350
4	24	7/16" x 14	2,000	500
5	25	1/2" x 13	2,600	650
6	26	9/16" x 12	3,200	750
7	27	5/8" x 11	4,000	1,000
8	28	3/4" x 10	6,000	1,500
9	29	7/8" x 9	7,000	1,750
10	30	1" x 8	9,000	2,250
11	31	1-1/8" x 7	12,000	2,500
12	32	1-1/4" x 7	15,000	3,750
14	34	1-1/2" x 6	21,000	4,900

Working load limits for eye bolts are based on a straight vertical lift in a gradually increasing manner. Angular lifts (Shoulder Pattern only) will significantly lower working load limits and should be avoided whenever possible. Angular lifts (Shoulder Pattern only) must never be more than a 45° pull.

Reprinted from the Chicago Hardware 2003 catalog
www.chicagohardware.com

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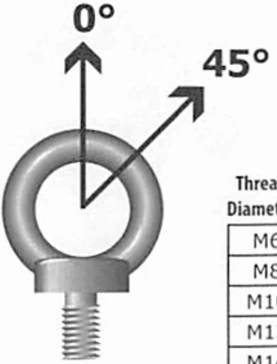
DIN 580 Eyebolts

Metric style Eyebolts



Not authorized for use below 45 degrees

Material: mild steel

Thread Diameter	*Working Load Limit (kg)* 0°	45°
M6	70	50
M8	140	95
M10	230	170
M12	340	240
M14	490	340
M16	700	500
M20	1200	830
M22	1500	1050
M24	1800	1270
M27	2500	1650
M30	3600	2600
M33	4300	3200
M36	5100	3700
M42	7000	5000
M45	8000	5500
M48	8600	6100
M52	9900	7300
M56	11500	8300
M64	16000	11000
M72	21000	15000
M80	28000	20000
M100	38000	27000

Reference:
DIN 580 - Lifting Eye Bolts Specifications

Eyebolts from an unknown manufacturers or with unknown material types should NEVER be used for overhead lifting!

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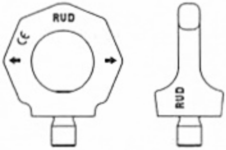
RUD® Startpoint VRS



Type Inch	WLL in lbs
VRS-3/8" -16 UNC	880 lbs
VRS-1/2" - 13 UNC	1650 lbs
VRS-5/8" - 11 UNC	3300 lbs
VRS-3/4" - 10 UNC	5070 lbs
VRS-7/8" - 9 UNC	5070 lbs
VRS-1" - 8 UNC	7050 lbs
VRS-1 1/4" - 7 UNC	9920 lbs
VRS-1 1/2" - 6 UNC	15430 lbs
VRS-1 3/4" - 5 UNC	19480 lbs
VRS-2" - 4 UNC	26500 lbs

Rated loads are shown on each STARPOINT eyebolt, this table is for reference only.

Type metric	WLL metric tons
VRS-M8	0,4 t
VRS-M10	0,4 t
VRS-M12	0,75 t
VRS-M16	1,5 t
VRS-M20	2,3 t
VRS-M24	3,2 t
VRS-M30	4,5 t
VRS-M36	7 t
VRS-M42	9 t
VRS-M48	12 t

NOTE: STARPOINT's are not suited for turning under load!

Go to www.rud.com for additional information

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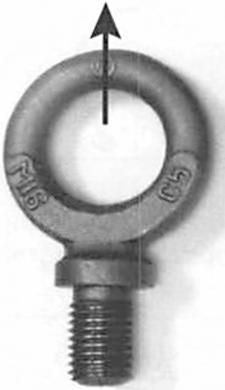
Other lifting eyes

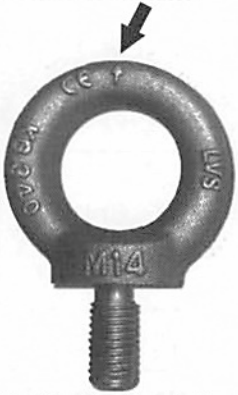
These eyebolts can only be loaded vertically

Typical applications include lifting jigs and electric motors

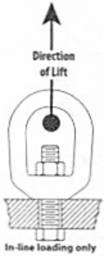
Note: force indicator



Dynamo eyebolt



Metric collared eyebolt



Eye nuts...

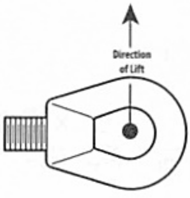
- should have full thread engagement
- shall only be used for in-line loads
- shall be in good working condition
- shock loading should be avoided.

ASME B30.26-2010

Eyebolts from an unknown manufacturers or with unknown material types should NEVER be used for overhead lifting!

High-Strength Lifting Eyes designed for 90°lifts

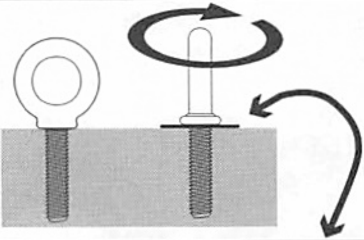
Rated Capacity at 90°
1" x 8 tpi: 9,000 lbs
1-1/4" x 7 tpi: 10,000 lbs
1-1/2" x 6 tpi: 15,000 lbs



Mfg. by EW Daniel Co.

Graphics ©2012 Jerry Klinke

Eyebolts

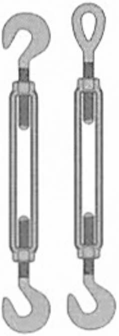


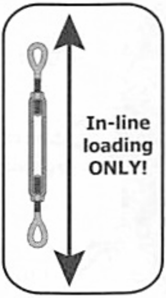
Eye Bolt size (inches)	Shim Thickness Required to change rotation 90 degrees (inches)
1/4" x 20 tpi	0.0125
5/16" x 18 tpi	0.0139
3/8" x 16 tpi	0.0156
1/2" x 13 tpi	0.0192
5/8" x 11 tpi	0.0227
3/4" x 10 tpi	0.0250
7/8" x 9 tpi	0.0278
1" x 8 tpi	0.0312
1-1/4" x 7 tpi	0.0357
1-1/2" x 6 tpi	0.0417

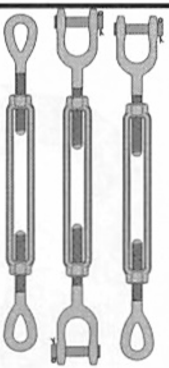
tpi = threads per inch

Graphics ©2012 Jerry Klinke

Turnbuckles





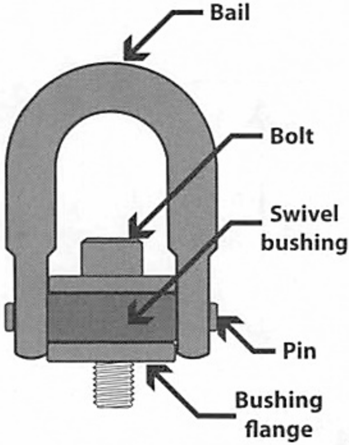


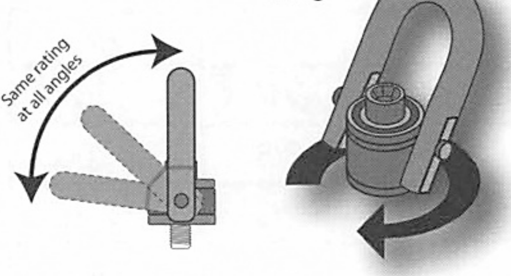
HOOK end fitting type	SIZE	**EYE & JAW end fitting types**
400	1/4"	500
700	5/16"	800
1,000	3/8"	1,200
1,500	1/2"	2,200
2,250	5/8"	3,500
3,000	3/4"	5,200
4,000	7/8"	7,200
5,000	1"	10,000
6,500	1-1/4"	15,200
7,500	1-1/2"	21,400

WLL values shown in pounds

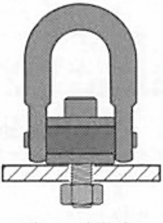
Graphics ©2012 Jerry Klinke

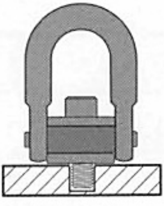
Swivel Hoist Rings


Bail
Bolt
Swivel bushing
Pin
Bushing flange


Same rating at all angles

360 degree rotation with 100% loading at any direction or angle


Through hole


Tapped hole

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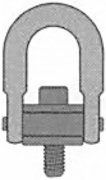
Swivel Hoist Rings



NOTE: Generic values shown. Consult the swivel hoist ring manufacturer for values with the equipment being used. ASME B30.26 requires these values be shown on each hoist ring.

Imperial

Bolt Size	**WLL** (1)	**Torque in Ft. Lbs.**
5/16" - 18 tpi	800	7
3/8" - 16 tpi	1000	12
1/2" - 13 tpi	2500	28
5/8" - 11tpi	4000	60
3/4" - 10 tpi	5000	100
7/8" - 9 tpi	8000	160
1" - 8 tpi	10000	230
1-1/4" - 7 tpi	15000	470
1-1/2" - 6 tpi	24000	800

(1) Working Load Limit (lbs.)

Metric

Bolt Size	**WLL** (2)	**Torque in Nm**
M8 x 1.25 x 40	400	10
M10 x 1.50 x 40	450	16
M12 x 1.75 x 55	1050	38
M16 x 2.00 x 65	1900	81
M20 x 2.50 x 70	2150	136
M20 x 2.50 x 80	3000	136
M24 x 3.00 x 90	4200	312
M30 x 3.50 x 140	7000	637
M36 x 4.00 x 130	11000	1005

(2) Working Load Limit (kg)

Tightening torque values shown are based upon threads being clean, dry and free of lubrication

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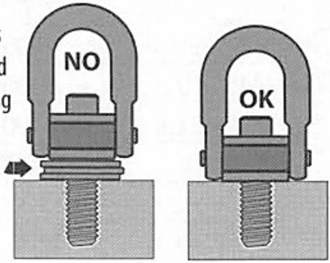
SLINGS
HARDWARE
FORMULAS
WEIGHTS
OPERATIONS
STANDARDS
HAND SIGNALS

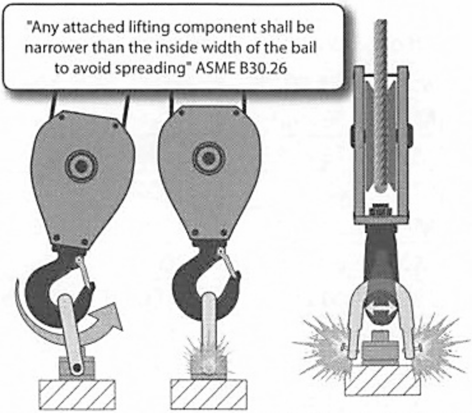
Swivel Hoist Rings

Key issues when using Hoist Rings:

- The hoist ring must be fully seated
- The threads of the bolt fully engaged in the hole
- Shall be tightened to the torque specifications of the manufacturer
- Torque values are based upon threads being dry and free of lubrication
- Bolt specifications are typically Grade 8 Alloy socket head cap screw
- All torque values are based on threads that are UNC (not UNF)
- When used in a through-hole application, a nut and washer shall be used
- The bushing flange shall fully contact the load surface
- Spacers or washers shall not be used between the bushing flange and mounting surface of the load



Spacers or washers **SHALL NOT** be used between the bushing flange and the mounting surface



"Any attached lifting component shall be narrower than the inside width of the bail to avoid spreading" ASME B30.26

This means to not use something (like a hook) that would be wider than the inside of the bail of the hoist ring - like in this example

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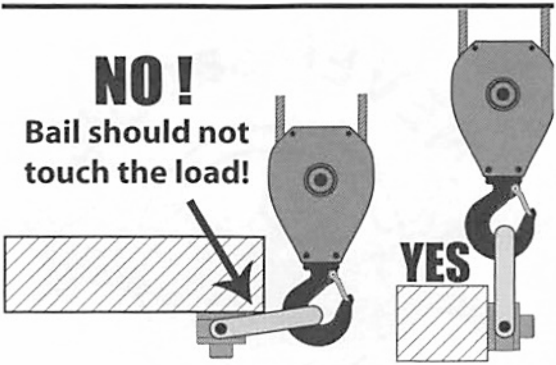
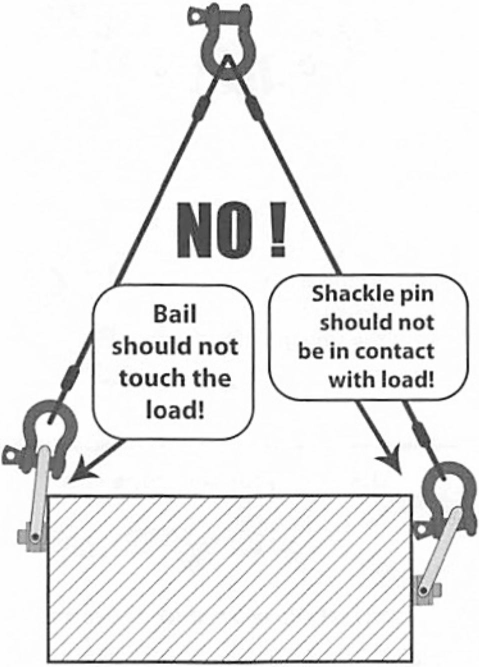
Swivel Hoist Rings


NO!
Bail should not touch the load!
YES


NO!
Bail should not touch the load!
Shackle pin should not be in contact with load!

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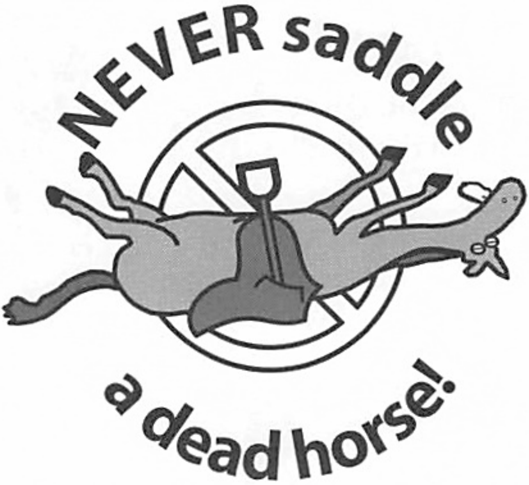
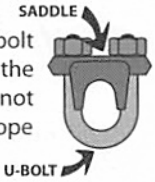
Wire Rope Clips

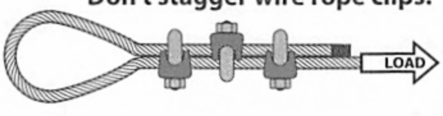

NEVER saddle
a dead horse!

This common phrase is a way to remember the correct way to install a wire rope clip

It tells you that the U-bolt goes on the dead end of the rope – where crushing will not affect the strength of the rope


SADDLE
U-BOLT

Don't stagger wire rope clips!



One incorrect clip will reduce the capacity

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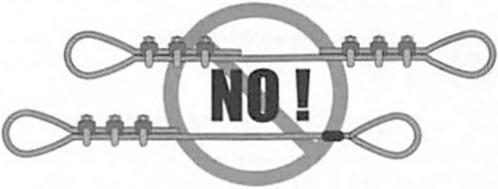
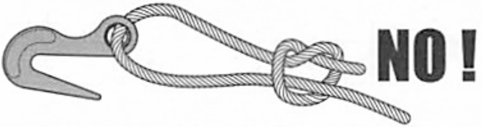
Wire Rope Clips



"Wire rope clips shall not be used to fabricate wire rope slings except where the application of slings prevents the use of prefabricated slings and where the specific application is designed by a qualified person."

ASME B30.9



"Eyes in wire rope bridles, slings, or bull wires shall not be formed by wire rope clips or knots."

OSHA 1926.251(c)(4)(iii)

What does this mean?

Basically, that you shouldn't fabricate wire rope slings for general repetitive daily use.

However - for special or one-time unusual lifts wire rope clips may be used to fabricate rigging including slings. This method should only be used in special cases, provided the wire rope clips' manufacturer's recommendations are followed explicitly.

Refer to AMSE B30 for additional information

You can use wire rope clips on other applications .
. . . but when it comes to SLINGS. . . you shouldn't!
Don't fabricate a sling with a piece of wire rope
and some wire rope clips. . . . see ASME B30.9

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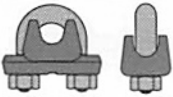
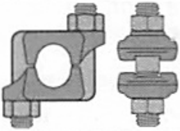
Wire Rope Clips



Consult the equipment manufacturer for specific installation requirements.

Wire Rope Clips - Installation data			
SIZE	Number of clips (minimum)	Turnback	Torque in Foot-lbs
1/8"	2	3-1/4"	4.5
3/16"	2	3-3/4"	7.5
1/4"	2	4-3/4"	15
5/16"	2	5-1/4"	30
3/8"	2	6-1/2"	45
7/16"	2	7"	65
1/2"	3	11-1/2"	65
9/16"	3	12"	95
5/8"	3	12"	95
3/4"	4	18"	130
7/8"	4	19"	225
1"	5	26"	225
1-1/8"	6	34"	225
1-1/4"	7	44"	360
1-3/8"	7	44"	360
1-1/2"	8	54"	360
1-5/8"	8	58"	430
1-3/4"	8	61"	590
2"	8	71"	750
2-1/4"	8	73"	750

Wire Rope Clips



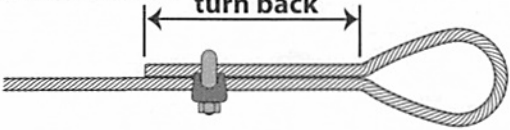
Consult the equipment manufacturer for specific installation requirements.

Double Saddle, Wire Rope Clips - Installation data			
SIZE	Number of clips (minimum)	Turnback	Torque in Foot-lbs
3/16"	2	4"	30
1/4"	2	4"	30
5/16"	2	5"	30
3/8"	2	5-1/4"	45
7/16"	2	6-1/2"	65
1/2"	3	11"	65
9/16"	3	12-3/4"	130
5/8"	3	13-1/2"	130
3/4"	3	16"	225
7/8"	4	26"	225
1"	5	37"	225
1-1/8"	5	41"	360
1-1/4"	6	55"	360
1-3/8"	6	62"	500
1-1/2"	7	78"	500

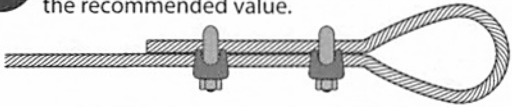
Wire Rope Clips

1 Determine the amount of turn back required, as shown on the tables

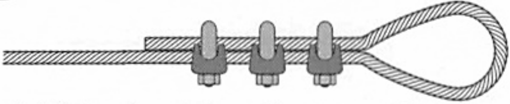
Apply first clip one base width from the dead end of the rope. Tighten nuts evenly and torque at the recommended value.



2 Apply the second clip as near to the loop as possible. Tighten nuts evenly and torque at the recommended value.



3 Apply the rest of the clips as indicated in the tables. Space clips accordingly and torque.



Apply light tension, tighten all nuts to specified torque

4 Recheck and re-tighten nuts after the initial load. This load should be at least equal to loads expected in general use.

Wire rope will stretch slightly causing a reduction in diameter which will slacken the clips. Nuts should be checked at frequent intervals for proper tightness.

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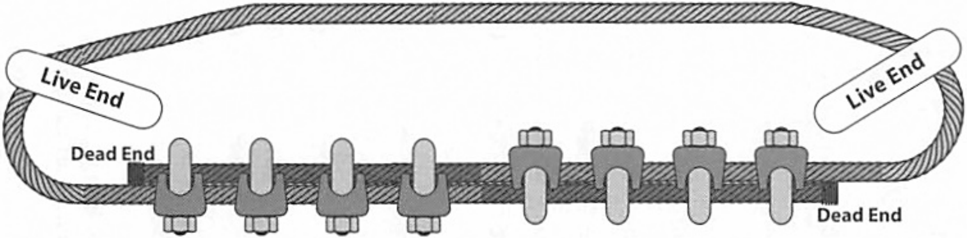
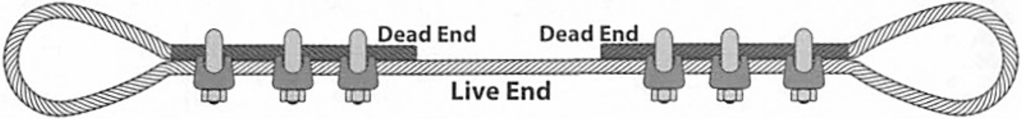
Wire Rope Clips

Examples of correct wire rope clip use


Live End
Live End
Dead End
Dead End

OSHA 1926.251(c)(4)(ii) "Except for eye splices in the ends of wires and for endless rope slings, each wire rope used in hoisting or lowering, or in pulling loads, shall consist of one continuous piece without knot or splice"

OSHA 1926.251(c)(4)(iii) "Eyes in wire rope bridles, slings, or bull wires shall not be formed by wire rope clips or knots"


Dead End
Dead End
Live End

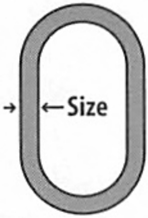
Graphics ©2012 Jerry Klinke

Masterlinks

Oblong master links

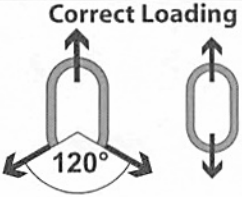
DO NOT USE THE VALUES SHOWN BELOW WITH UNKNOWN MANUFACTURERS EQUIPMENT!

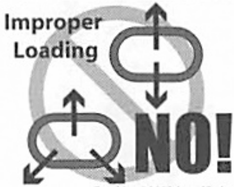
Links by other manufacturers will have different Working Load Limits



Values shown are in US lbs

Size	CM	Crosby	Gunnebo	Avg Wt (lb)
3/8"	3600	----	3300	0.44
1/2"	6100	7400	7000	0.82
5/8"	N/A	9000	11400	1.52
3/4"	12300	12300	12300	2.07
1"	20800	15200	29900	4.85
1-1/4"	31300	26000	35200	9.57
1-1/2"	49000	39100	68000	16.22
1-3/4"	73500	61100	84900	25.22
2"	88900	84900	102600	37.04
2-1/4"	125200	143100	143100	54.1
2-1/2"	----	160000	160000	67.76
2-3/4"	187800	216900	220200	87.7
	Herc-Alloy 5:1 Design	Alloy Steel 5:1 Design	Grade 100 5:1 Design	





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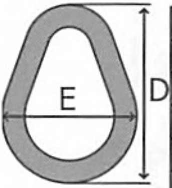
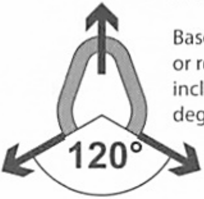
Masterlinks

Alloy Pear Link *Crosby A-341*

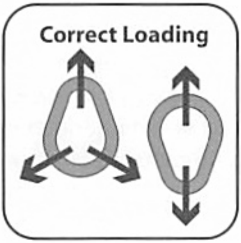


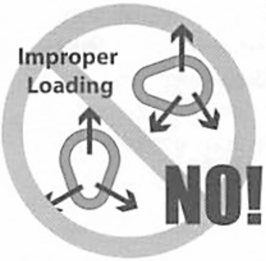
DIA	WLL	"D"	"E"
1/2"	7,000	2.5	5
5/8"	9,000	3	6
3/4"	12,300	2.75	5.5
7/8"	14,000	3.75	6.38
1"	24,360	3.5	7
1-1/4"	36,000	4.38	8.75
1-1/2"	54,300	5.25	10.5
1-3/4"	84,900	6	12
2"	102,600	7	14
2-1/4"	143,100	8	16

The data shown above is only valid when using A-341 Alloy Pear Shaped Links manufactured by The Crosby Group. WLL Data taken from Crosby 2006 catalog



Based on Single leg slings (in-line load) or resultant load on multiple legs with an included angle less than or equal to 120 degrees.





DO NOT USE THE VALUES SHOWN ABOVE WITH UNKNOWN MANUFACTURERS EQUIPMENT!

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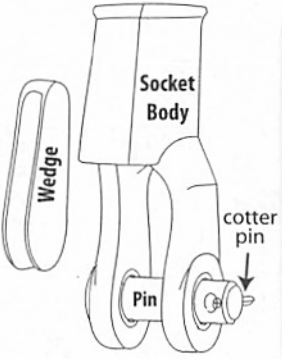
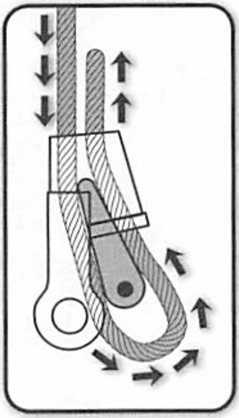
SLINGS
HARDWARE
FORMULAS
WEIGHTS
OPERATIONS
STANDARDS
HAND SIGNALS

Wedge Sockets



Components



Make sure that the wedge is correct for the wire rope size! Do not interchange wedges between metric and US sizes.

The size is shown on the side of the wedge and on the socket body.

When using wedge sockets:
Make sure that a sudden impact does not dislodge a wedge
Check frequently to re-tighten or re-position as necessary
Do not interchange different manufacturer's wedge sockets
Apply a load to fully seat the wedge, wire rope and socket
Do not side load a wedge socket
Read and understand the manufacturer's instructions before installing a wedge socket

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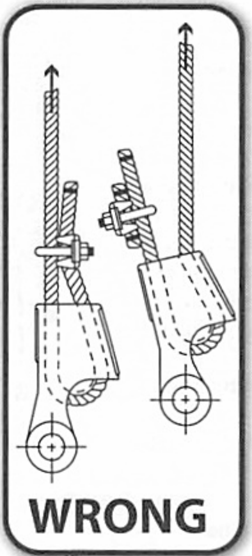
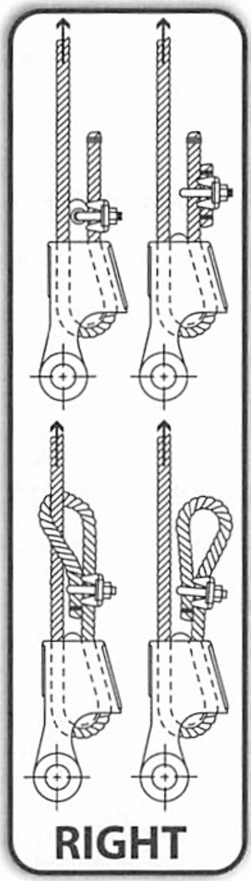
Wedge Sockets

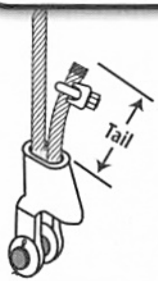
Wire rope clips used with wedge sockets shall be attached only to the dead end of the rope ..

See ASME B30.26 and B30.5 for additional information



NOTE: Rotation Resistant Rope requires additional precautions.





Typical tail lengths:

Standard wire ropes

6 wire rope diameters (minimum)

Rotation resistant ropes

20 rope diameters (minimum)

The tail length of the dead end of the wire rope should never be less than 6 inches.

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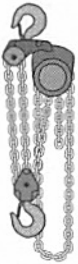
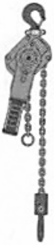
Basic Hoist Operating Practices

You SHALL NOT:



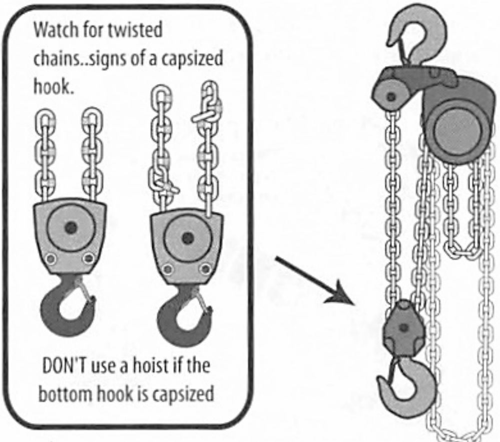


1. lift more than rated load for the hoist
2. use damaged hoist or malfunctioning hoist
3. use hoist with twisted, kinked, or damaged chain
4. use hoist if the bottom hook is capsized
5. use the hoist to lift, or support people
6. shock load the hoist
7. operate hoist when it is restricted from forming a straight line from hook to hook in the direction of loading
8. use load chain as a sling or wrap load chain around load
9. use in a way that causes either hook to be side-loaded.
10. allow the chain, or hook to be used as an welding ground
11. operate a hoist on which the safety placards or decals are missing or illegible
12. attempt to lengthen or repair damaged load chain

You SHALL:

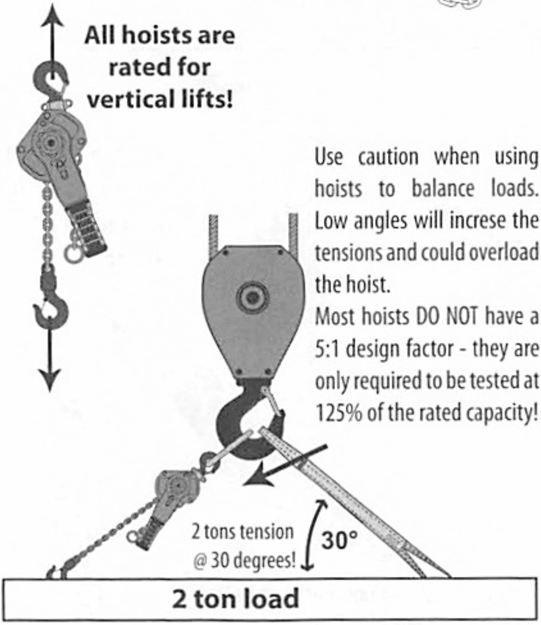
1. Be familiar with operating controls, and warnings
2. Make sure the hoist is securely attached to a suitable support before applying load
3. Take up slack carefully - make sure load is balanced and the load brake is holding before continuing
4. Make sure all persons stay clear of the load
5. Protect the hoist's load chain from weld splatter
6. Report malfunctions of the hoist and remove the hoist from service until the malfunction is resolved.
7. Warn personnel before lifting or moving a load

Hoists



Watch for twisted chains..signs of a capsized hook.

DON'T use a hoist if the bottom hook is capsized



All hoists are rated for vertical lifts!

Use caution when using hoists to balance loads. Low angles will increse the tensions and could overload the hoist.

Most hoists DO NOT have a 5:1 design factor - they are only required to be tested at 125% of the rated capacity!

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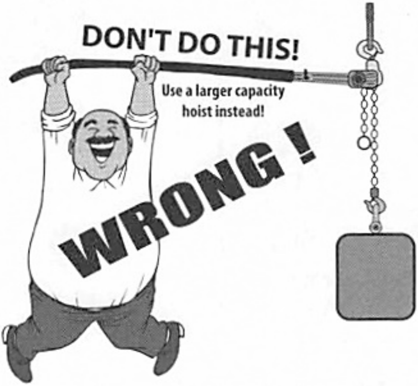
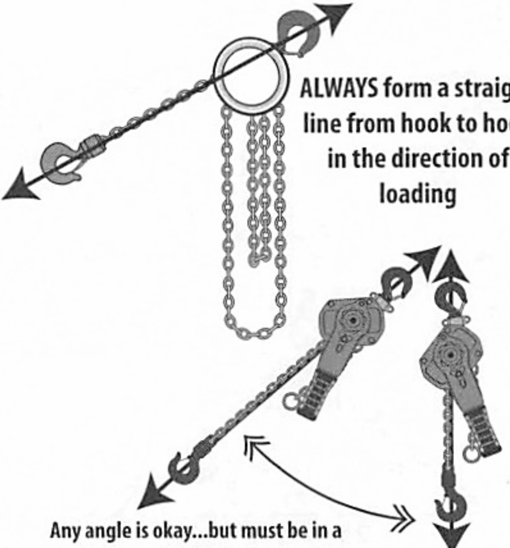
Lever Hoists

Lever Hoists are designed so that ONE average sized person can use it WITHOUT any "cheaters", pipes or extensions.


DON'T DO THIS!
Use a larger capacity hoist instead!
WRONG!

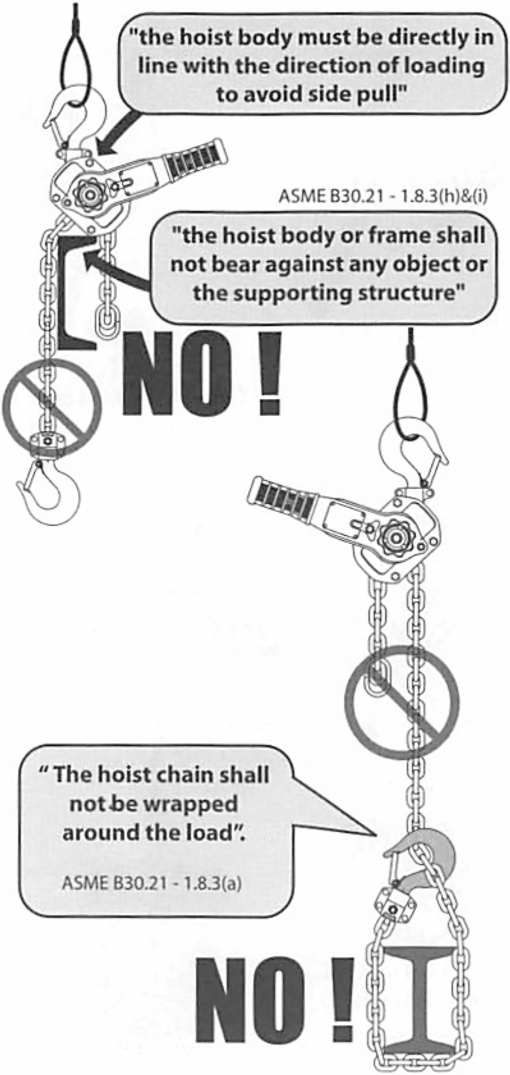


ALWAYS form a straight line from hook to hook in the direction of loading

Any angle is okay...but must be in a straight line of pull, hook to hook...

Graphics ©2012 Jerry Klinke

Lever Hoists



"the hoist body must be directly in line with the direction of loading to avoid side pull"

ASME B30.21 - 1.8.3(h)&(i)

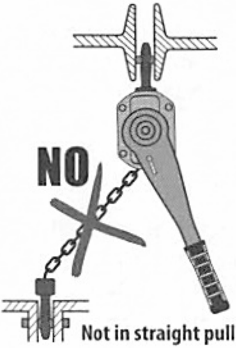
"the hoist body or frame shall not bear against any object or the supporting structure"

" The hoist chain shall not be wrapped around the load".

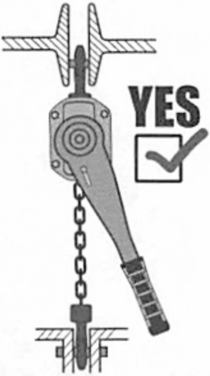
ASME B30.21 - 1.8.3(a)

Graphics ©2012 Jerry Klinke

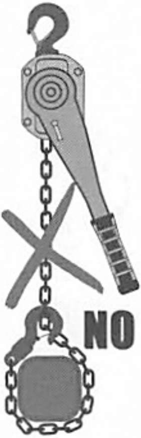
Lever Hoists



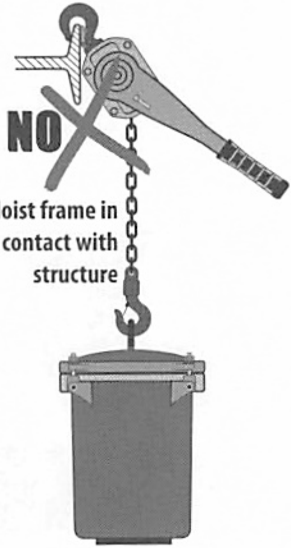
Not in straight pull



CORRECT - the hoist body is directly in-line with the direction of loading



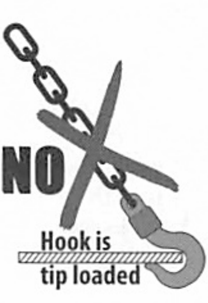
hoist chain is wrapped around the load



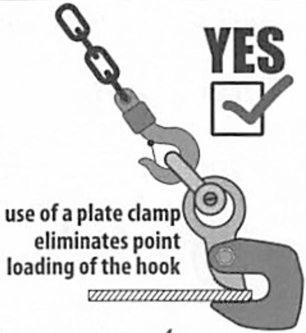
Hoist frame in contact with structure

Graphics ©2012 Jerry Klinke

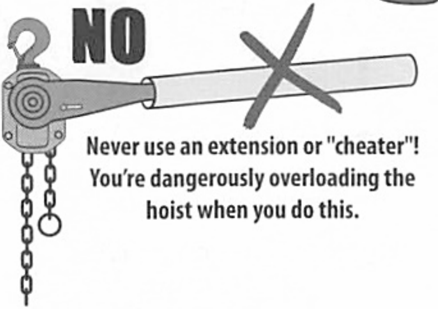
Lever Hoists



Hook is tip loaded

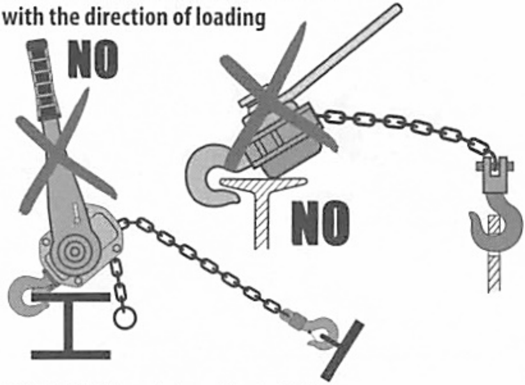


use of a plate clamp eliminates point loading of the hook



Never use an extension or "cheater"! You're dangerously overloading the hoist when you do this.

the hoist body is NOT directly in-line with the direction of loading



ASME B30.21 Manually Lever Operated Hoists

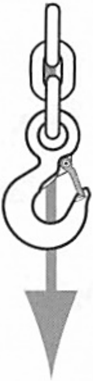
Graphics ©2012 Jerry Klinke

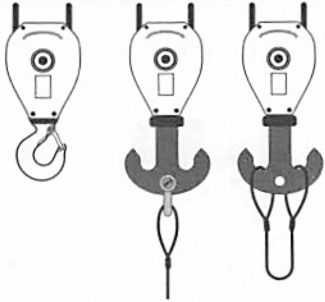
Hooks

ASME B30.10 divides hooks into 2 groups:

Direct-pull

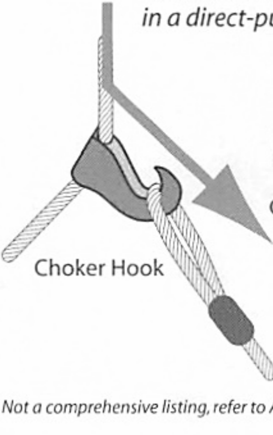
Hooks supporting a load in a direct-pull configuration, with the load carried in the base of the hook



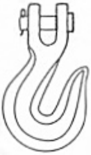


NOT in direct-pull

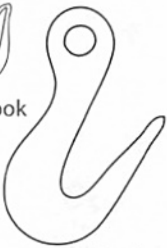
Hooks that do not support a load in a direct-pull configuration



Choker Hook



Grab Hook



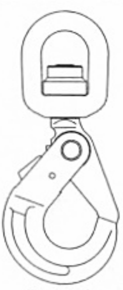
Sorting Hook

Not a comprehensive listing, refer to ASME B30.10 for specifics.

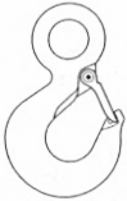
Graphics ©2012 Jerry Klinke

Hooks

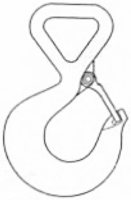
Some commonly used hooks for lifting/rigging operations



Eye Hook
Self-Locking

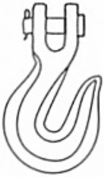


Eye Hook
w/latch

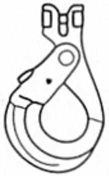


Eye Hook
for web slings

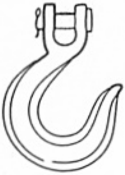
Eye hooks – The wire rope or a shackle is attached to the hook through the hook's eye.



Clevis Grab Hook

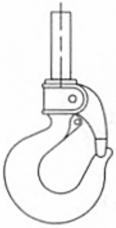


Clevis Hook
Self-Locking



Clevis Hook

Clevis hooks – Designed to be attached to chain, the link is secured by the pin in the clevis design.

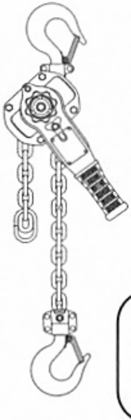


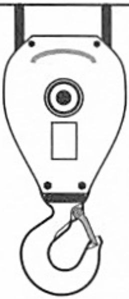
Shank hooks – Shank hooks are specifically design to swivel 360°. The one shown has a Self-Closing Gate Latch (sometimes called a Bullard hook).

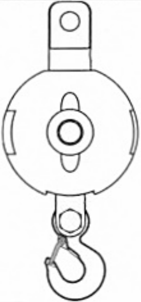
Refer to ASME B30.10 "Hooks" for additional information.

Graphics ©2012 Jerry Klinke

Hooks



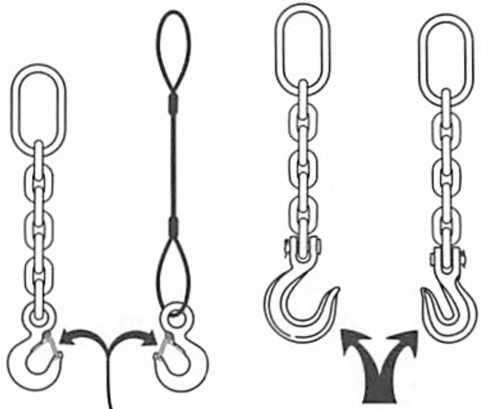




"Hooks shall be equipped with latches unless the use of a latch creates a hazardous condition"

If the hook has a latch – it MUST function properly!

ASME B30.9 does not specifically require latches on slings with hooks. It DOES require latches, if present, must function and seat properly.

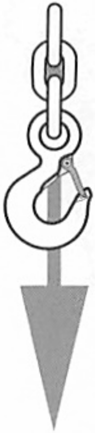


If it comes WITH a latch - it's required

If it didn't come with a latch - it's NOT required

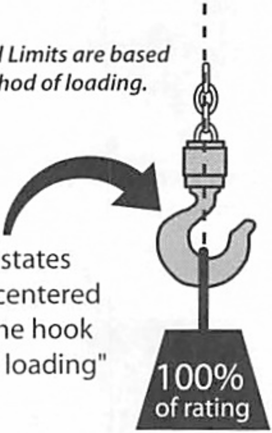
Graphics ©2012 Jerry Klinke

Hooks



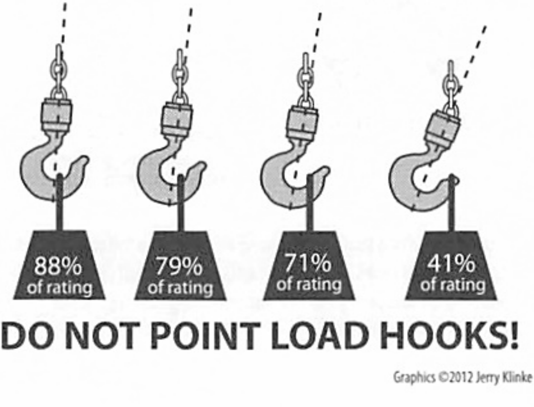
Hooks (in direct pull) are designed for in-line loading. This is a condition where the load is applied through the centerline of the hook in a straight pull.

Working Load Limits are based on this method of loading.


100%
of rating

ASME B30.10 states "Loads shall be centered in the base of the hook to prevent point loading"

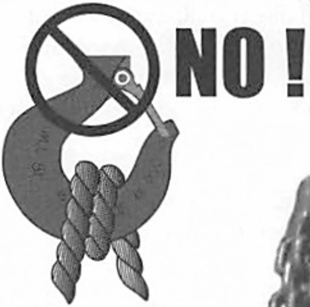
The illustration below shows how quickly the capacity of the hook decreases with point loading.


88%
of rating
79%
of rating
71%
of rating
41%
of rating

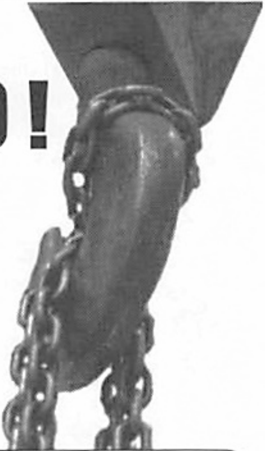
DO NOT POINT LOAD HOOKS!

Graphics ©2012 Jerry Klinke

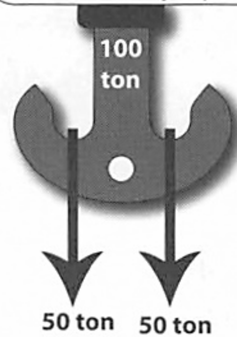
Hooks

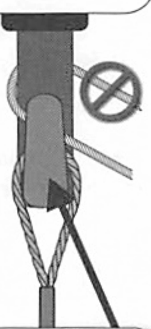


Don't wrap slings around the hook



ASME B30.10 "Duplex (sister) hooks shall be loaded equally on both sides"



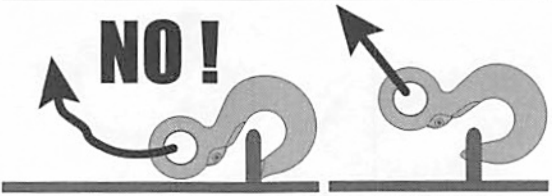


Only the prongs of a hook are rated for a load

Quad hook lifting shall be done with all prongs loaded and rigged to balance prong forces. Hook manufacturer or qualified person shall be consulted for two prong and unbalanced-prong loading... ASME B30.10

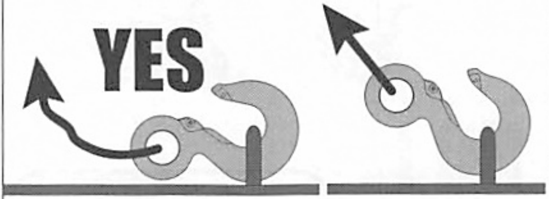
Graphics ©2012 Jerry Klinke

Hooks

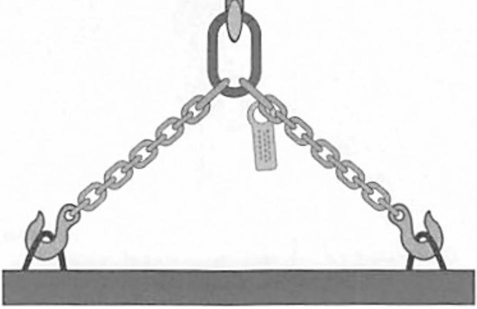


Hooks that face in will have a higher chance of fouling, resulting in point loading the hook

- Hooks face OUT -



Hooks that face OUT will have less chance of fouling and will and rotate into position and center themselves



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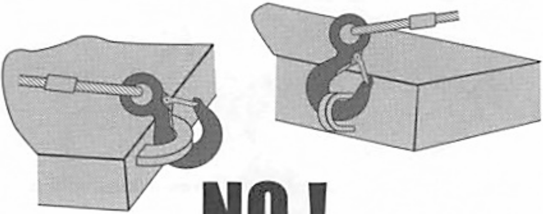
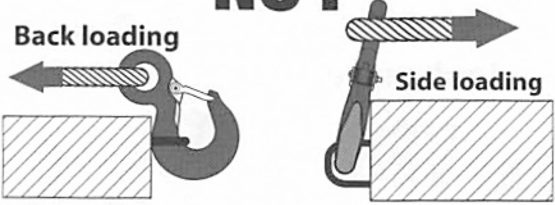
SLINGS
HARDWARE
FORMULAS
WEIGHTS
OPERATIONS
STANDARDS
HAND SIGNALS

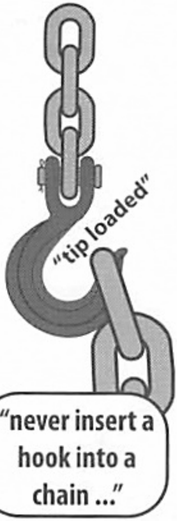
Hooks



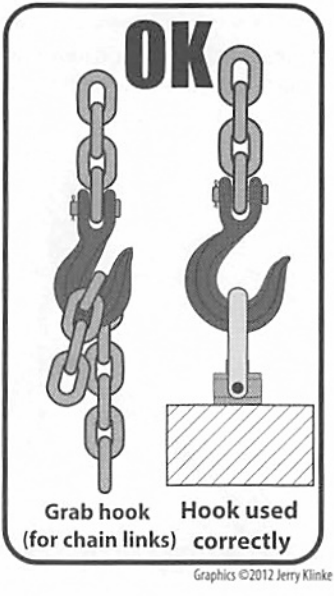
NO !


Back loading
Side loading

NO !



"never insert a hook into a chain ..."

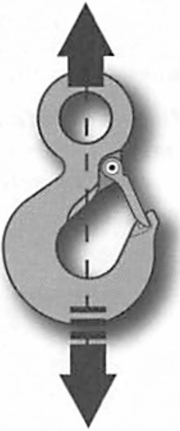

OK
Grab hook (for chain links)
Hook used correctly

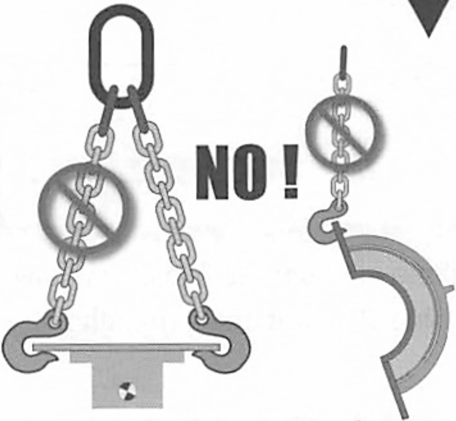
Graphics ©2012 Jerry Klinke

Hooks

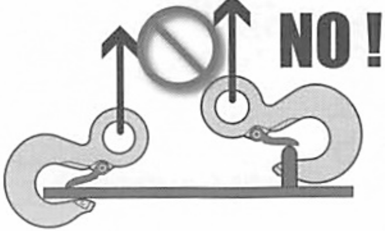
ASME B30.10 "Load shall be centered in the base of the hook to prevent point loading of the hook"

Hooks are designed, tested and rated for in-line tension





Don’t Tip Load Hooks!



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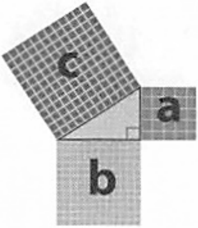
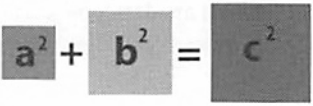
Math & Conversions

Pythagoras' Theorem

Many years ago, a man named Pythagoras found an amazing fact about triangles:

If the triangle had a right angle (90°) ... and you made a square on each of the three sides, then ... the biggest square had the exact same area as the other two squares put together!

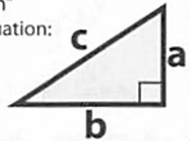




$$a^2 + b^2 = c^2$$

It's called "Pythagoras' Theorem"
and can be written in one short equation:

$$a^2 + b^2 = c^2$$



Use these equations to find an unknown side of a right angle triangle:

$$a = \sqrt{c^2 - b^2}$$

$$b = \sqrt{c^2 - a^2}$$

$$c = \sqrt{a^2 + b^2}$$

Example:

$5^2 + 12^2 = c^2$

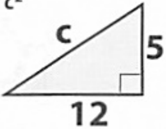
$25 + 144 = c^2$

$169 = c^2$

$c^2 = 169$

$c = \sqrt{169}$

$c = 13$



If a number is squared, it is multiplied by itself
Example: 5^2 is the same as $5 \times 5 = 25$

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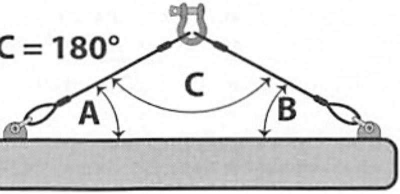
Math & Conversions

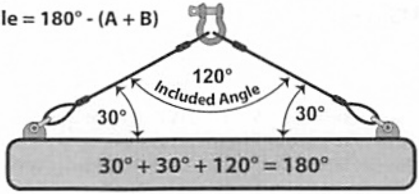
Triangles Contain 180°

In a triangle, the three angles always add to 180°:

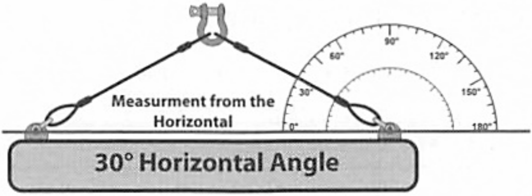
A + B + C = 180°

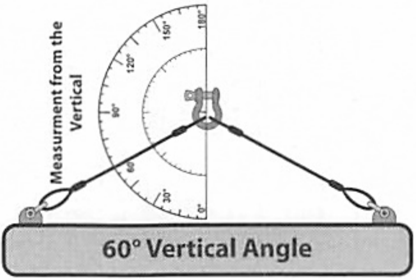


Included Angle = 180° - (A + B)


120°
Included Angle
30°
30°
30° + 30° + 120° = 180°

180° - (30° + 30°) = 120° Included Angle


90°
60°
120°
30°
150°
0°
180°
Measurment from the Horizontal
30° Horizontal Angle


Measurment from the Vertical
180°
150°
120°
90°
60°
30°
0°
60° Vertical Angle

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Math & Conversions

Converting inches to tenths of a foot

1 Inch = 0.08 Feet (1 Inch = 0.0833 Feet)

Example: What is 6 inches in tenths of a foot
use your calculator and type in "6 x .0833 =" (answer will be 0.4998)

Converting Fractions to Decimals

Just divide the top of the fraction by the bottom, and read off the answer

Example: What is 5/8 as a decimal ... ?
use your calculator and enter: 5 / 8 = (answer will be 0.625)

US ton vs Metric Ton

There is 2000 lbs in a US ton, and 2,204.62 lbs in a metric tonne

Sometimes the US ton is called a "short" ton (t)
and a metric tonne is called a "long" Ton (T)

Convert US lbs to US tons: DIVIDE lbs by 2000
Example: 5,000 lbs / 2000 = 2.5 tons US
Convert US tons to US lbs: MULTIPLY tons by 2000
Example: 6.8 tons X 2000 = 13,600 lbs US
Metric tons to US lbs: MULTIPLY metric tons by 2204
Example: 5 metric tons X 2204.62 = 11,023 lbs US

Percentage of Crane Capacity

The total load to be lifted DIVIDED by the maximum rated capacity of the crane

Example: 13 ton load / 20 ton crane capacity = .65 or 65% of crane capacity

Note: with mobile cranes the maximum crane capacity is dependent on the manufacturers load chart rating with the current crane configuration (boom radius, boom angle, boom length, parts of block, etc.)

Calculate minimum D/d for wire rope

Wire rope diameter MULTIPLY by 25 (or whatever the D/d ratio is)

Example: (for 1/2" wire rope that requires a 25:1 D/d) .5 X 25= 12.5"

WR Dia	25:1	WR Dia	25:1
1/4"	6-1/4"	7/8"	21-7/8"
5/16"	7-7/8"	1"	25"
3/8"	9-3/8"	1-1/8"	28-1/8"
1/2"	12-1/2"	1-1/4"	31-1/4"
5/8"	15-5/8"	1-3/8"	34-3/8"
3/4"	18-3/4"	1-1/2"	37-1/2"

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Math & Conversions

UNITS OF MEASURE

1 US ton (short) = 2000 lbs
1 US ton (short) = .91 metric ton
1 US ton (short) = 907 kgs
1 metric ton = 2204.62 lbs
1 metric ton = 1.102 US tons
1 metric ton = 1000 kgs
1 US pound (lb) = 16 ounces
1 US pound (lb) = .45 kg
1 kilogram (kg) = 2.2 lbs
1 kilogram (kg) = 35 ounces
1 kilogram (kg) = 1000 grams
1 US (liq) gallon = 4 quarts
1 US (liq) gallon = 3.8 liters
1 liter = .264 gallons (US)
1 liter = 1.06 quarts
1 US gallon water = 8.3 lbs
1 cubic ft of liquid = 7.5 US gallons

The Metric System of Measurement

The metric system of measurement takes advantage of our base ten number system. The advantage of the metric system over the United States system is that in the metric system it is possible to convert from one unit of measure to another simply by multiplying or dividing the given number by a power of 10. This means we can make a conversion simply by moving the decimal point to the right or the left. The metric prefixes along with their meaning are shown below.

Metric Prefixes

deka — ten
hecto — hundred
kilo — thousand

deci — tenth
centi — hundredth
milli — thousandth

For example, if length is being measured;

1 kilometer is equivalent to 1000 meters.
1 centimeter is equivalent to one hundredth of a meter.
1 millimeter is equivalent to one thousandth of a meter.

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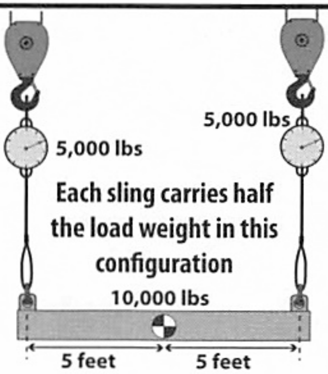
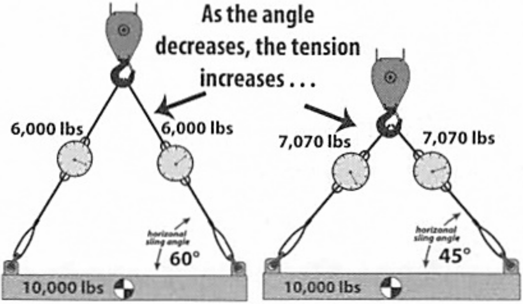
Tension Basics

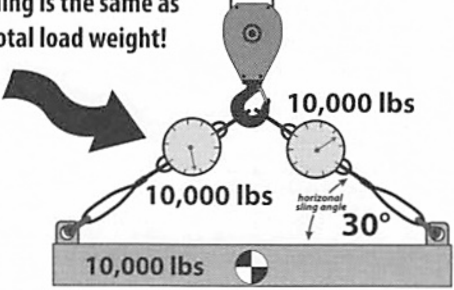

5,000 lbs
5,000 lbs
10,000 lbs
5 feet
5 feet

Each sling carries half the load weight in this configuration

As the angle decreases, the tension increases . . .


6,000 lbs
6,000 lbs
horizonal sling angle
60°
10,000 lbs
7,070 lbs
7,070 lbs
horizonal sling angle
45°
10,000 lbs

At 30 degrees the force on each sling is the same as the total load weight!


10,000 lbs
10,000 lbs
horizonal sling angle
30°
10,000 lbs

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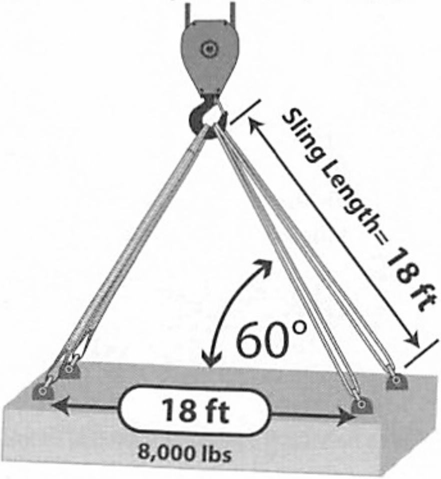
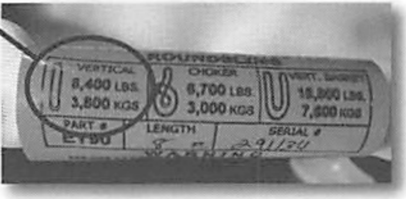
Quick sling selection

To have at least a 60 degree horizontal sling angle, measure between the attachment points, and select a sling that length (or longer)


Sling Length= 18 ft
60°
18 ft
8,000 lbs

Want a quick way to select the slings without calculating the tension? As long as you keep the horizontal sling angle above 60 degrees, select your slings as if EACH sling would support the entire weight of the load.

Example: Use 4 slings, EACH SLING with a Vertical rated capacity greater than 8,000 lbs


VERTICAL
8,400 LBS.
3,800 KGS
CHOKER
6,700 LBS
3,000 KGS
7,600 KGS
PART #
LENGTH
SERIAL #

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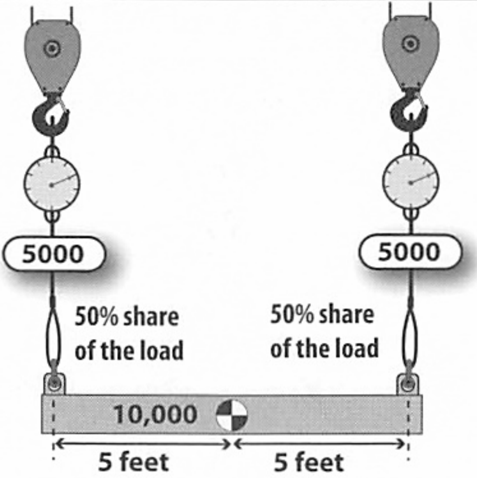
Load Share Basics


5000
5000
50% share of the load
50% share of the load
10,000
5 feet
5 feet

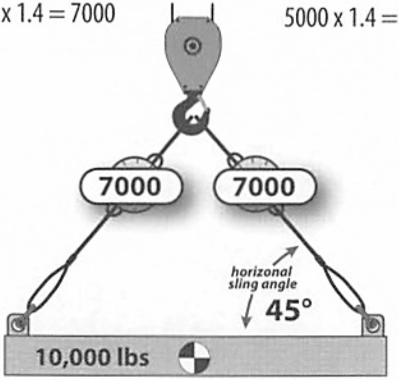
Load share x horizontal angle multiplier (LAF) = tension

LEFT SIDE

5000 x 1.4 = 7000

RIGHT SIDE

5000 x 1.4 = 7000


7000
7000
horizonal sling angle
45°
10,000 lbs

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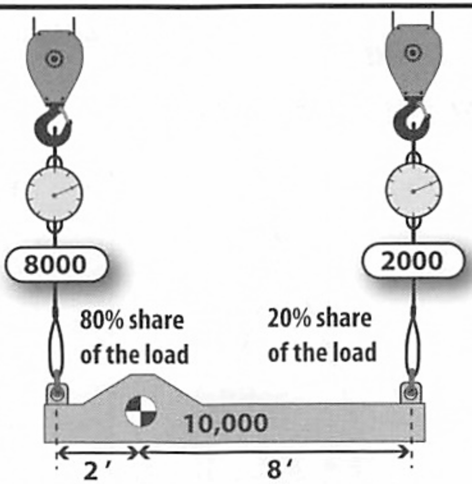
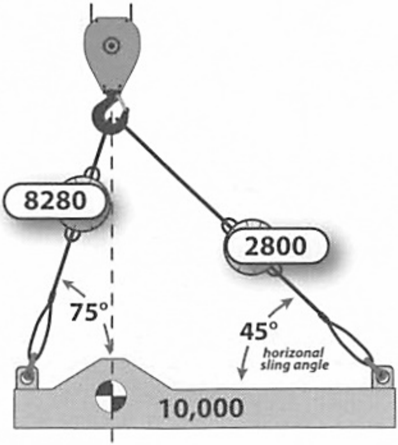
Load Share Basics


8000
2000
80% share of the load
20% share of the load
10,000
2′
8′

Load share x horizontal angle multiplier (LAF) = tension

LEFT SIDE
8000 x 1.035 = 8280

RIGHT SIDE
2000 x 1.4 = 2800


8280
2800
75°
45°
horizonal sling angle
10,000

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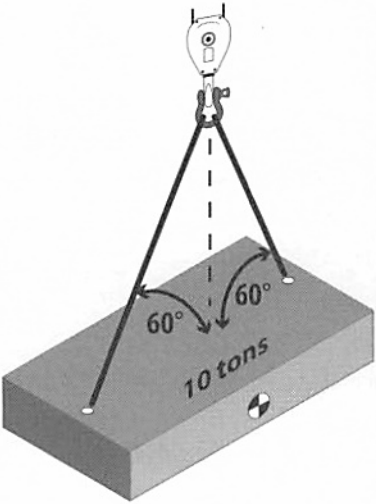
Tension Calculation

Formula:

by horizontal angle

(Weight ÷ No of legs) x L.A.F. (1)(2)



Horizontal Angle	L.A.F.
5 °	11.49
10 °	5.75
15 °	3.861
20 °	2.924
25 °	2.364
30°	2.00
35 °	1.742
40 °	1.555
45°	1.414
50 °	1.305
55 °	1.221
60°	1.155
65 °	1.104
70 °	1.064
75 °	1.035
80 °	1.015
85 °	1.004
90 °	1.00

Example:

Horizontal Angle = 60 degrees
Total weight = 10 tons

(10 tons ÷ 2 legs = 5 tons)

5 tons x 1.55 = 7.75 tons

(lbs tension each leg)

---

(1) It's recommended you only consider that 2 legs will carry the load, even when using 4 legs, because it's difficult to assure all 4 legs will carry an equal share of the load.

(2) Weight divided by the number of legs . . . the same as the "load share"

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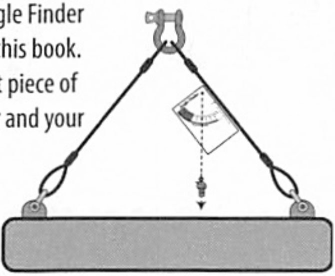
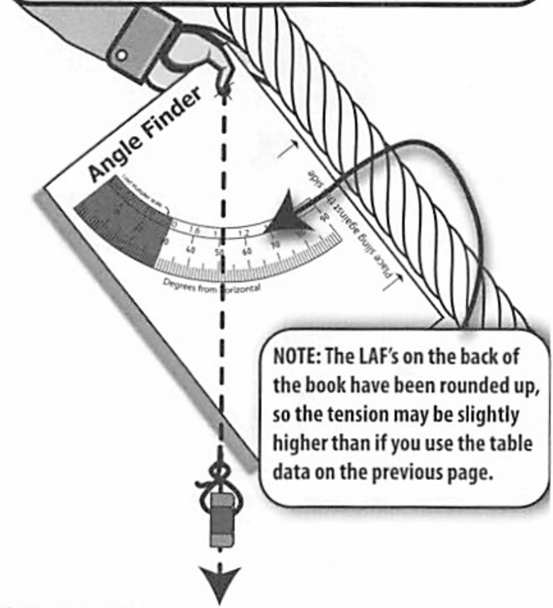
Angle Finder Use

You can determine the horizontal angle by using the Angle Finder that is on the back of this book. All you need is a short piece of string, a nut or washer and your thumb!



1) Attach a weight (nut or washer) to a short piece of string.
2) Place the edge of the book against the sling.
3) Hold the string in place with your thumb and forefinger.
4) Let the string hang freely and read the angle on the scale.


Angle Finder
Load Multiplier Scale
1.6
1.2
40
50
60
70
80
Degrees from horizontal
Place sling against this side

NOTE: The LAF's on the back of the book have been rounded up, so the tension may be slightly higher than if you use the table data on the previous page.

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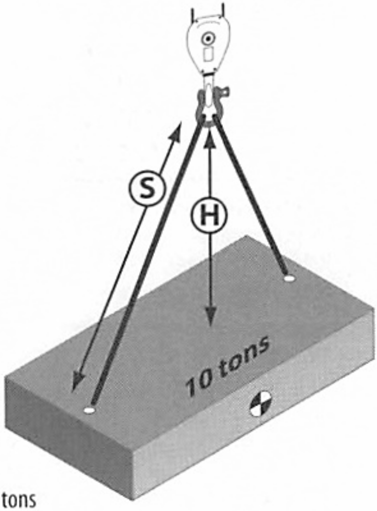
SLINGS
HARDWARE
FORMULAS
WEIGHTS
OPERATIONS
STANDARDS
HAND SIGNALS

Tension Calculation

by measurements

Formula:

(Weight ÷ No of legs) X (S ÷ H) (1)(2)



Example:
S = 9 feet
H = 7 feet
Total weight = 10 tons

First we find the multiplier (LAF)... **9 ÷ 7 = 1.28**

(10 tons ÷ 2 legs = 5 tons)

5 tons x 1.28 = 6.4 tons

(lbs tension each leg)

---

(1) It's recommended you only consider that 2 legs will carry the load, even when using 4 legs, because it's difficult to assure all 4 legs will carry an equal share of the load.

(2) Weight divided by the number of legs . . . the same as the "load share"

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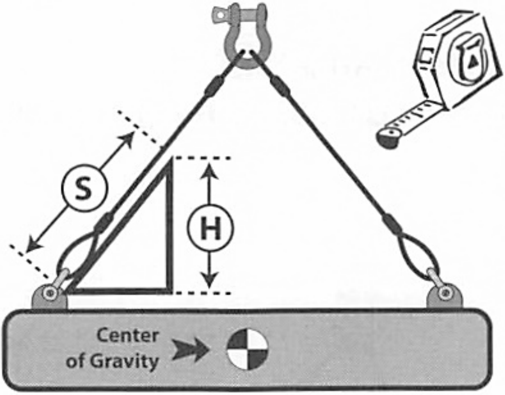
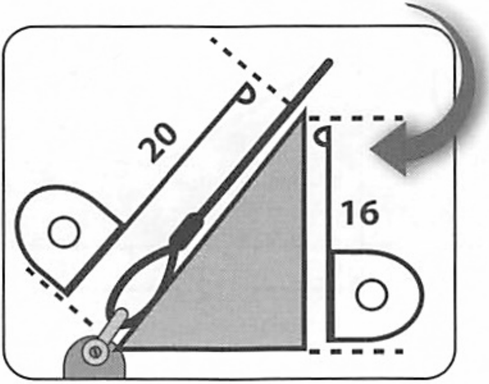
S/H field shortcut

Instead of measuring the sling length, you can also obtain the "S" & "H" dimensions by creating an "invisible triangle" with a tape measure



IMPORTANT: Make sure when measuring the "H" dimension that the tape is plumb (straight down) otherwise it will not be a true right angle triangle.



20 ÷ 16 = 1.25 .... that's your multiplier, or L.A.F.

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Non-symmetrical Loads

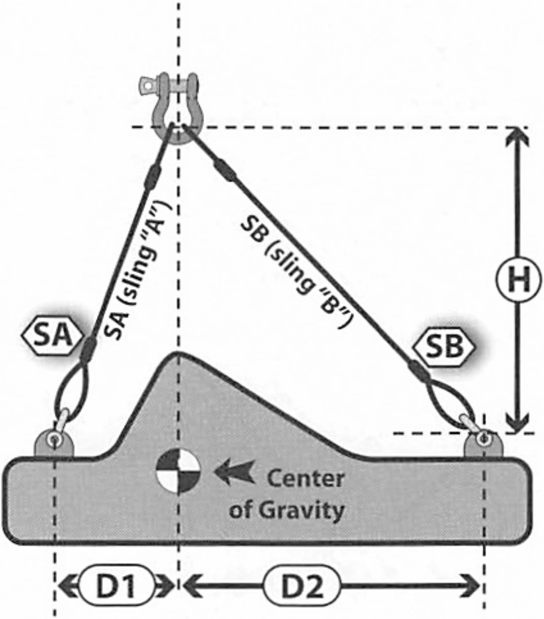
attachments at **SAME** elevation

Sling "A" Tension SA

$$(\text{Load} \times D2 \times SA) \div H \times (D1 + D2)$$

Sling "B" Tension SB

$$(\text{Load} \times D1 \times SB) \div H \times (D1 + D2)$$


SA (sling "A")
SB (sling "B")
SA
SB
H
Center of Gravity
D1
D2

NOTE: You must know the Center of Gravity location in order to use this formula

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Non-symmetrical Loads

attachments at **SAME** elevation

Values used in this example:

D1 = 40"
D2 = 63"
H = 60"
SA = 66"
SB = 78"

Weight of load = 10,000 lbs

Sling "A" Tension ⟨SA⟩

(Load x D2 x SA) ÷ H x (D1 + D2)

$$\underbrace{10{,}000 \times 63 \times 66 = 41580000}_{} \div \underbrace{60 \times (40 + 63) = 6{,}180}_{}$$

41580000 ÷ 6,180 = 6,728 lbs

Answer: **Sling "A" will have 6,728 lbs of tension**

Sling "B" Tension ⟨SB⟩

(Load x D1 x SB) ÷ H x (D1 + D2)

$$\underbrace{10{,}000 \times 40 \times 78 = 31200000}_{} \div \underbrace{60 \times (40 + 63) = 6{,}180}_{}$$

31200000 ÷ 6,180 = 5,049 lbs

Answer: **Sling "B" will have 5,049 lbs of tension**

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Non-symmetrical Loads

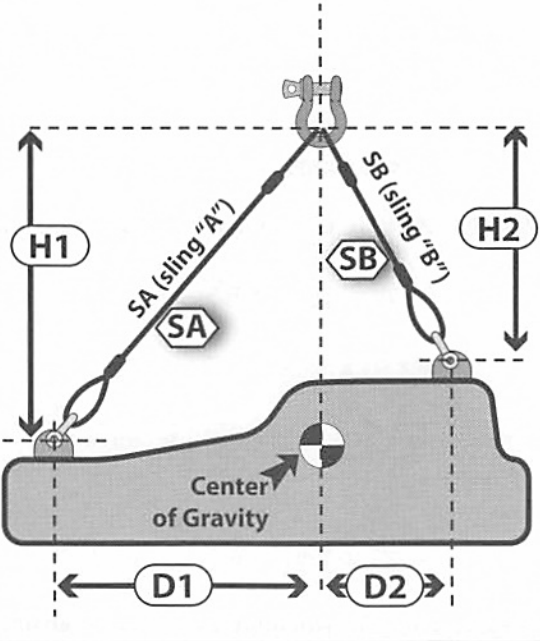
attachments at **DIFFERENT** elevations

Sling "A" Tension SA

(Load x D2 x SA) ÷ [(D2 x H1) + (D1 x H2)]

Sling "B" Tension SB

(Load x D1 x SB) ÷ [(D2 x H1) + (D1 x H2)]


H1
SA (sling "A")
SA
SB (sling "B")
SB
H2
Center of Gravity
D1
D2

NOTE: You must know the Center of Gravity location in order to use this formula

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Non-symmetrical Loads

attachments at **DIFFERENT** elevations

Values used in this example:

D1 = 55" D2 = 27" H1 = 60"
SA = 81" SB = 36" H2 = 24"

Weight of load = 6,000 lbs

Sling "A" Tension ⟨SA⟩

$$(\text{Load} \times D2 \times SA) \div [(D2 \times H1) + (D1 \times H2)]$$

$$\underbrace{6000 \times 27 \times 81 = 13122000} \div \underbrace{27 \times 60 = 1{,}620 + 55 \times 24 = 1{,}320}_{1{,}620 + 1{,}320 = 2{,}940}$$

$$13122000 \div 2{,}940 = \mathbf{4{,}463}$$

Answer: **Sling "A" will have 4,463 lbs of tension**

Sling "B" Tension ⟨SB⟩

$$(\text{Load} \times D1 \times SB) \div [(D2 \times H1) + (D1 \times H2)]$$

$$\underbrace{6000 \times 55 \times 36 = 11880000} \div \underbrace{27 \times 60 = 1{,}620 + 55 \times 24 = 1{,}320}_{1{,}620 + 1{,}320 = 2{,}940}$$

$$11880000 \div 2{,}940 = \mathbf{4{,}040}$$

Answer: **Sling "B" will have 4,040 lbs of tension**

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Drifting Loads

To determine how much tension will be placed upon chainfalls used in angular rigging situations, use the following formula:

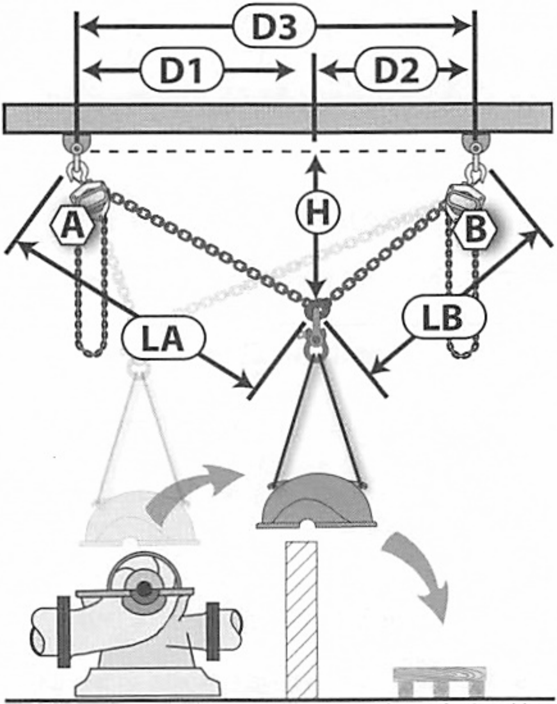
Tension on Chainfall ⟨A⟩

(Load weight × D2 × LA) ÷ (H × D3)

Tension on Chainfall ⟨B⟩

(Load weight × D1 × LB) ÷ (H × D3)

Tip: The H dimension is at the HIGHEST point during the move



NOTE: This formula assumes that both chainfalls are positioned at the same elevation and that there is a single attachment point on the load.

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Drifting Loads

Values used in this example:

D1 = 48" D2 = 96" D3 = 144"
LA = 60" LB = 102.5" H = 36"

Weight of load = 2,000 lbs

Tension on Chainfall A

$$(\text{Load} \times D2 \times LA) \div (H \times D3) = A$$

$$2000 \times 96 \times 60 = 11{,}520{,}000 \div 36 \times 144 = 5{,}184$$

$$11{,}520{,}000 \div 5{,}184 = 2{,}222$$

Answer: Chainfall "A" will carry 2,222 lbs of tension

Tension on Chainfall B

$$(\text{Load} \times D1 \times LB) \div (H \times D3) = B$$

$$2000 \times 48 \times 102.5 = 9{,}840{,}000 \div 36 \times 144 = 5{,}184$$

$$9{,}840{,}000 \div 5{,}184 = 1{,}898$$

Answer: Chainfall "B" will carry 1,898 lbs of tension

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Tightlines

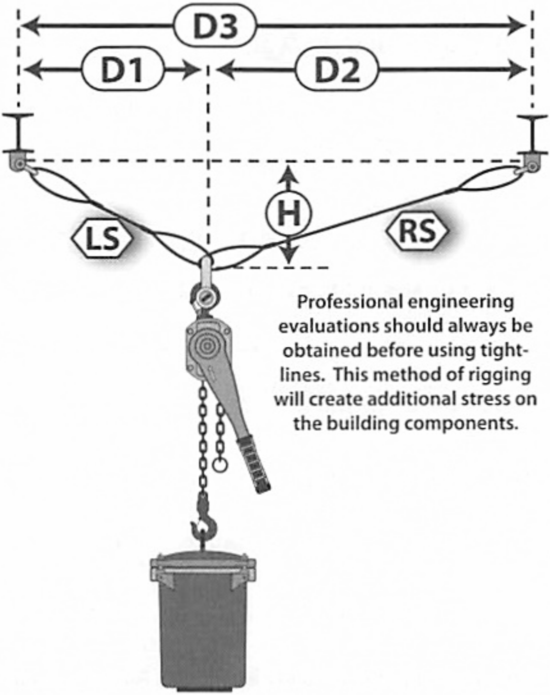
To determine how much tension will be placed upon slings used in angular rigging situations, use the following formula:

Tension on the Left Sling LS

$$(\text{Load} \times D2 \times LS) \div (H \times D3)$$

Tension on the Right Sling RS

$$(\text{Load} \times D1 \times RS) \div (H \times D3)$$



Professional engineering evaluations should always be obtained before using tightlines. This method of rigging will create additional stress on the building components.

NOTE:This formula is based on both sides being attached at the same elevation

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Tightlines

Values used in this example:

D1 = 40"   D2 = 105"   D3 = 145"
LS = 48"   RS = 120"   H = 28"

Weight of load = 1,000 lbs

Tension on the Left Sling LS

(Load × D2 × LS) ÷ (H × D3)

1000 x 105 x 48 = 5,040,000 ÷ 28 x 145 = 4,060

5,040,000 ÷ 4,060 = 1,241

Answer:

The LEFT sling will have 1,241 lbs of tension

Tension on the Right Sling RS

(Load × D1 × RS) ÷ (H × D3)

1000 x 40 x 120 = 4,800,000 ÷ 28 x 145 = 4,060

4,800,000 ÷ 4,060 = 1,182

Answer:

The RIGHT sling will have 1,182 lbs of tension

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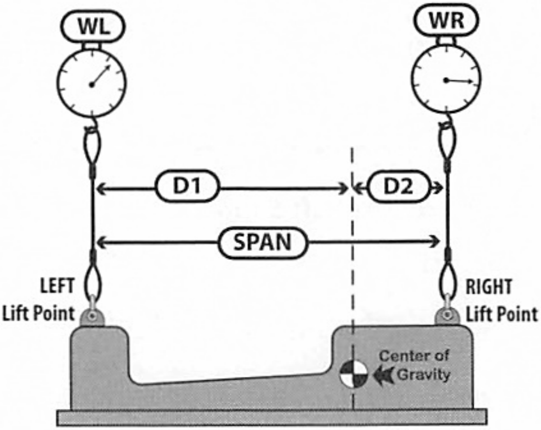
Find the Center of Gravity

by end weights

You MUST know:

☑ the weight of each end
☑ the distance between lift points



Locate the CG from the LEFT (D1)

(WR / TW) x SPAN = D1

Locate the CG from the RIGHT (D2)

(WL / TW) x SPAN = D2

Note: You only need to calculate one side to locate the CG

Legend

CG = Center of Gravity
D1 = Distance from LEFT lift point to CG
D2 = Distance from RIGHT lift point to CG
SPAN = Distance between lift points
WL = LEFT End Weight
WR = RIGHT End Weight
TW = Total Weight (WL+WR)

WL + WR = TW
WL / TW = Percentage (of load share)

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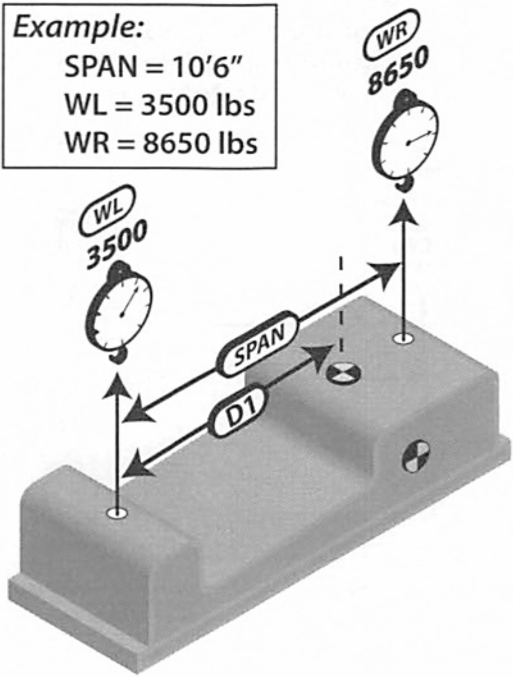
Find the Center of Gravity

by end weights

Example:

SPAN = 10′6″
WL = 3500 lbs
WR = 8650 lbs



Step 1: Convert 10′ 6″ into inches
10′ 6″ = 126″

Step 2: Find the total weight
3500+8650=12150

Find CG from the LEFT side (D1)
Step 3: **(WR/TW) x SPAN**
(8650 / 12150) x 126″ = 89″

You can also use tenths of a foot, or any metric units, the formula will work with all these units of measurements.

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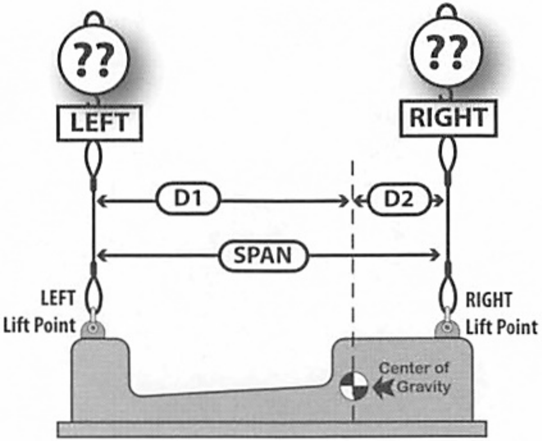
Determine Load Share

You MUST know:

- ☑ the approximate CG location
- ☑ distance from CG to lift points
- ☑ approximate total weight


??
??
LEFT
RIGHT
D1
D2
SPAN
LEFT Lift Point
RIGHT Lift Point
Center of Gravity

Load Share - LEFT end

(D2 /SPAN) x TW = LEFT

Load Share - RIGHT end

(D1 / SPAN) x TW = RIGHT

Note: You only need to calculate one side, then subtract it from the TW for the other end

Legend

CG = Center of Gravity
D1 = Distance from LEFT lift point to CG
D2 = Distance from RIGHT lift point to CG
SPAN = Distance between lift points
LEFT = Load share LEFT end
RIGHT = Load share RIGHT end
TW = Total Weight (approximate)
WL + WR = TW
WL / TW = Percentage (of load share)

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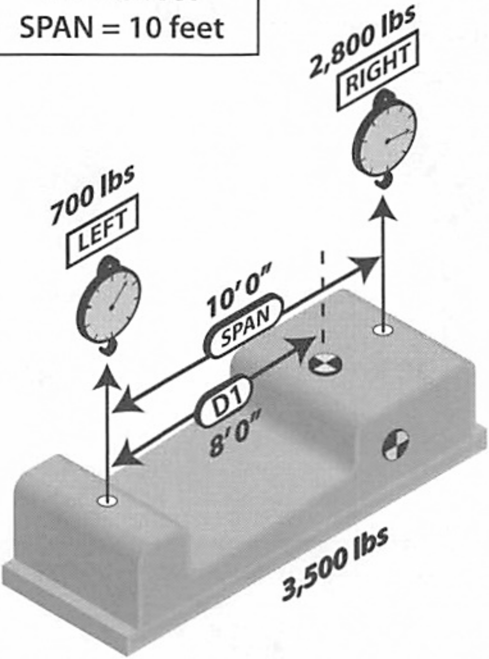
Determine Load Share

Example:
TW = 3500 lbs
D1 = 8 feet
SPAN = 10 feet


2,800 lbs
RIGHT
700 lbs
LEFT
10'0"
SPAN
D1
8'0"
3,500 lbs

Step 1: Find Load Share for the RIGHT side
(D1/SPAN) x TW
(8 / 10) x 3500 = 2800

Step 2:

Subtract the RIGHT side from the total weight and you get the LEFT side share:
3500 - 2800 = 700

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Load share - 2 crane lift

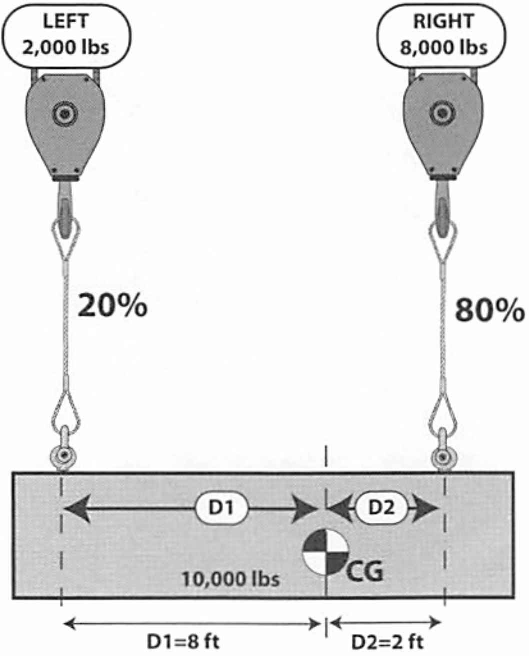
Load Weight Distribution - Level Lift

Load on LEFT crane

$\left(\frac{D2}{D1+D2}\right)$ x Load Weight

Load on RIGHT crane

$\left(\frac{D1}{D1+D2}\right)$ x Load Weight


LEFT
2,000 lbs
RIGHT
8,000 lbs
20%
80%
D1
D2
10,000 lbs
CG
D1=8 ft
D2=2 ft

LEFT END:
2 /(8+2) x 10,000 = 2,000 lbs.

RIGHT END:
8/ (8+2) x 10,000 = 8,000 lbs.

RIGHT SIDE is closest to CG - it will have the greatest share of the load.

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Load share - 2 crane lift

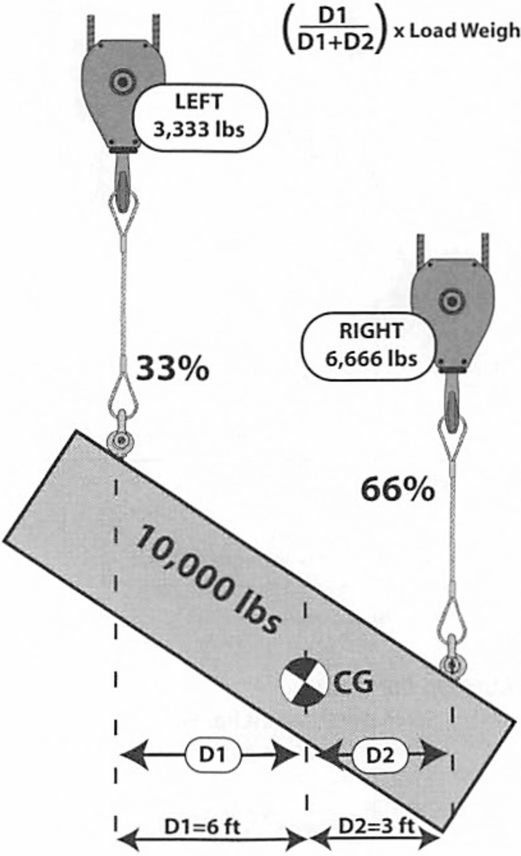
Load Weight Distribution - NOT Level Lift

Load on LEFT crane

$\left(\frac{D2}{D1+D2}\right)$ x Load Weight

Load on RIGHT crane

$\left(\frac{D1}{D1+D2}\right)$ x Load Weight


LEFT
3,333 lbs
33%
RIGHT
6,666 lbs
66%
10,000 lbs
CG
D1
D2
D1=6 ft
D2=3 ft

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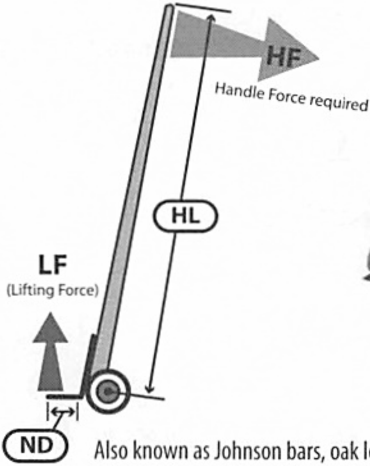
Leverage

(LF x ND) ÷ HL = *Handle Force*



Also known as Johnson bars, oak lever dollies, pry bars, pry trucks, and mules, these levers are often used to lift the end of a load

Legend

HL = Handle Length
HF = Handle Force (required force)
LF = Lifting Force (Load weight)
ND = Nose Distance

Johnson bar data:

Wood Handle w/Cast Iron Wheels
5 foot (60") handle, capacity = 3,500 lbs
6 foot (72") handle, capacity = 4,250 lbs
7 foot (84") handle, capacity = 5,000 lbs
Nose Length is typically 3" long

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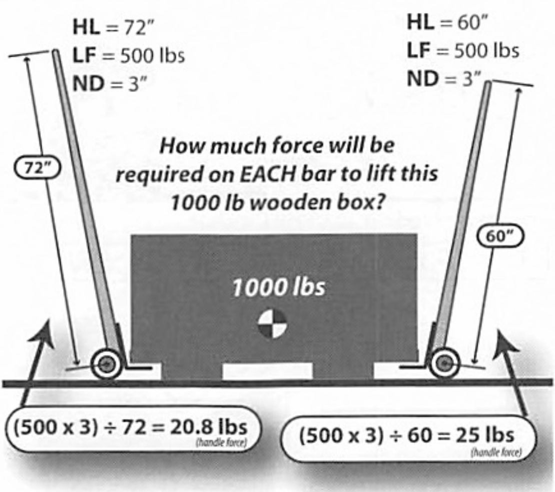
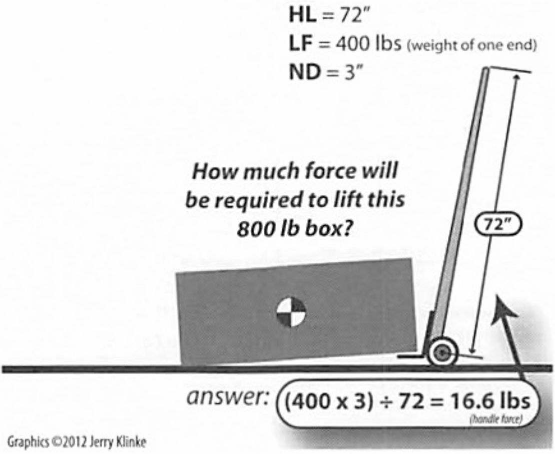
Leverage


HL = 72″
LF = 500 lbs
ND = 3″
HL = 60″
LF = 500 lbs
ND = 3″
72″
How much force will be required on EACH bar to lift this 1000 lb wooden box?
60″
1000 lbs
(500 x 3) ÷ 72 = 20.8 lbs
(handle force)
(500 x 3) ÷ 60 = 25 lbs
(handle force)


HL = 72″
LF = 400 lbs (weight of one end)
ND = 3″
How much force will be required to lift this 800 lb box?
72″
answer:
(400 x 3) ÷ 72 = 16.6 lbs
(handle force)

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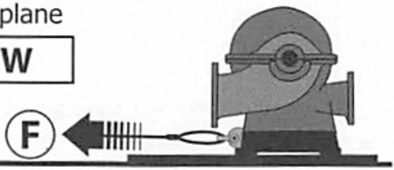
Pulling Force

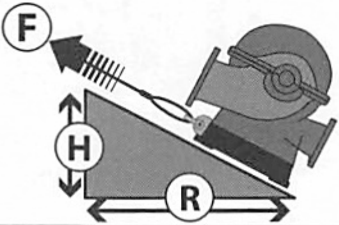
To move a load
on a LEVEL plane

$$\boxed{F = CF \times W}$$



To move a load on an UPHILL incline

$$\boxed{F = [CF \times W \times (R \div L)] + [(H \div L) \times W]}$$



To move a load on a DOWNHILL incline:

$$\boxed{F = [CF \times W \times (R \div L)] - [(H \div L) \times W]}$$

LEGEND	
W =	Weight of load
CF =	Coefficient of friction
F =	Force required to move load
H =	HEIGHT (Vertical distance in feet)
R =	RUN (Horizontal distance in feet)

These coefficient of friction values apply to hard, clean surfaces sliding against each other. These may not directly relate to your application due to actual surface conditions.

Surfaces	CF
Concrete on concrete	0.65
Metal on concrete	0.60
Steel on steel	0.20
Cast iron on steel	0.25
Load on wheels	0.05
Load on ice	0.01
Wood on wood	0.50
Wood on metal	0.30
Wood on concrete	0.45
Continuous Lubricated Surface	0.15

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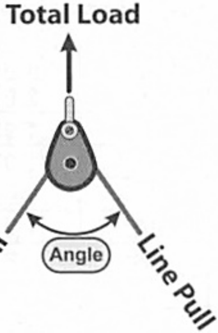
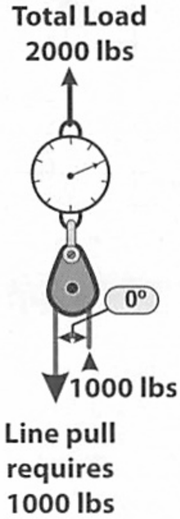
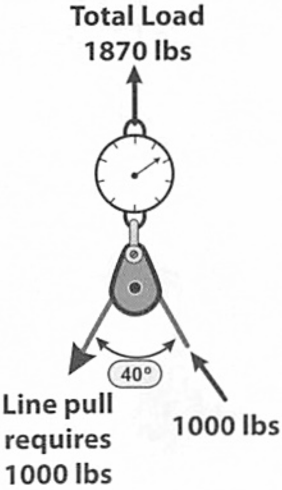
Block Basics

A single sheave block used to change load line direction can be subjected to total loads greatly different from the weight being lifted or pulled. The total load value varies with the angle between the incoming and departing lines to the block.


Total Load
Angle
Line Pull
Line Pull


Total Load
2000 lbs
0°
1000 lbs
Line pull
requires
1000 lbs

NOTE: The total load at the pulley attachment point is always greater than the weight of the load being lifted!


Total Load
1870 lbs
40°
Line pull
requires
1000 lbs
1000 lbs

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Block Basics

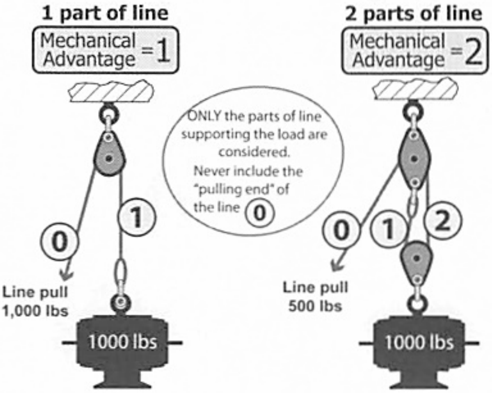
Total Load = Line Pull x Angle Factor

Example: 5000 lbs line pull at 40° (5000 x 1.87) a total load of 9,350 lbs

Angle	*Factor*	*Angle*	*Factor*
0°	2.00	100°	1.29
10°	1.99	110°	1.15
20°	1.97	120°	1.00
30°	1.93	130°	0.84
40°	1.87	135°	0.76
45°	1.84	140°	0.68
50°	1.81	150°	0.52
60°	1.73	160°	0.35
70°	1.64	170°	0.17
80°	1.53	180°	0
90°	1.41	--	--

Mechanical Advantage

$$\text{Pull Required} = \frac{\text{Weight to be lifted}}{\text{Mechanical Advantage}}$$


1 part of line
Mechanical Advantage = 1
2 parts of line
Mechanical Advantage = 2
ONLY the parts of line supporting the load are considered. Never include the "pulling end" of the line ⓪
⓪
①
Line pull 1,000 lbs
1000 lbs
⓪
①
②
Line pull 500 lbs
1000 lbs

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Block Basics

Since the block "A" is a traveling block, the mechanical advantage is 2 because two parts of load line support the 1,000 lbs load (Block bearing friction NOT considered).

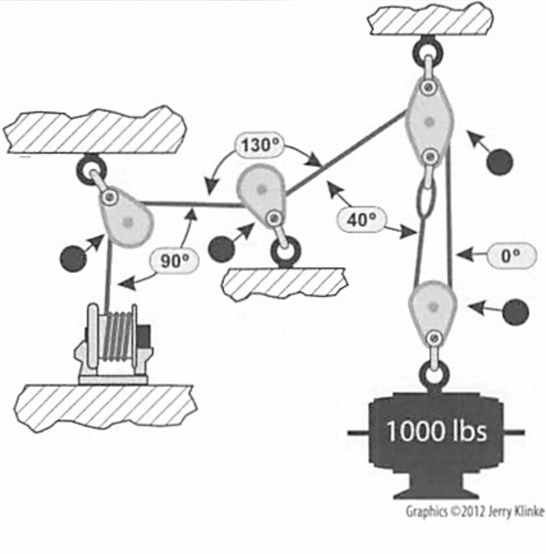
To determine line pull (force required to lift load):
1000 ÷ 2 = 500 lbs

To determine load on block "A":
(line pull) × (factor of 0 degrees)
500 lbs × 2.00 = 1,000 lbs

To determine load on block "B":
500 lbs × 1.87 + 500 lbs = 1,435 lbs

To determine load on block "C":
500 lbs × .84 = 420 lbs

To determine load on block "D":
500 lbs × 1.41 = 705 lbs



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Weight of Materials

Density of Materials

Material	lbs/cu ft	lbs/cu in	kg/cu m
Aluminum	165	0.095	2643
Brass	534	0.309	8554
Brick, common	120	0.069	1922
Bronze	510	0.295	8169
Cast Iron	480	0.278	7689
Concrete (Reinforced)	150	0.087	2403
Clay (compacted)	109	0.063	1746
Copper	560	0.324	8970
Diesel Fuel	52	0.030	833
Earth, dry, excavated	78	0.045	1249
Earth, wet, excavated	100	0.058	1602
Glass	160	0.093	2563
Gold	1254	0.726	19300
Granite, solid	168	0.097	2691
Gravel, w/sand, natural	120	0.069	1922
Gypsum wall board	54	0.031	865
Ice, solid	58	0.034	929
Lead, rolled	711	0.411	11389
Limestone, solid	163	0.094	2611
Marble, solid	160	0.093	2563
Sand, dry	100	0.058	1602
Sand w/ Gravel, wet	125	0.072	2002
Snow, freshly fallen	10	0.006	160
Snow, compacted	30	0.017	481
Steel	490	0.284	7849
Tungsten	1224	0.708	19606
Water, pure	62	0.036	993
Water, sea	64	0.037	1025
Wood			
Fir, Douglas	33	0.019	529
Maple, dry	44	0.025	705
Oak, red	44	0.025	705
Pine, White, dry	26	0.015	416
Pine, Yellow, dry	45	0.026	721

While this data is useful for estimating, individual samples will differ, Impurities will often have an influence.

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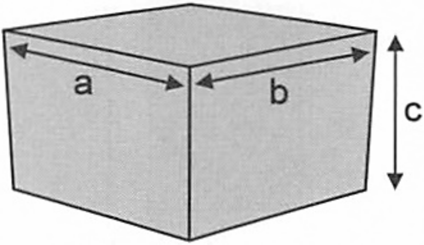
Volume: Cube

① Determine the volume of the object

$a \times b \times c = \text{volume}$

② Determine the approximate weight of the object

volume × weight (per Cu)



EXAMPLE:

a = 12 inches	c = 5 inches
b = 24inches	Material: Steel

Step 1 find the volume:

12 X 24 X 5 = 1440 Cu inches

Step 2 find the weight:

1440 X .2836 = 408.38 lb

Answer: 408 pounds

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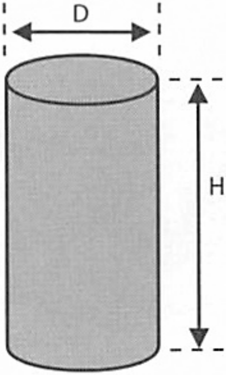
Volume: Solid Round

① Determine the volume of the object

VOLUME = 0.7854 X D X D X H

② Determine the approximate weight of the object

WEIGHT = Volume X Weight (per Cu)



EXAMPLE:

D = 18 inches
H = 42inches

Material: Steel

Step 1 find the volume:

0.7854 X 18 X 18 X 42 = 10687.72 Cu in

Step 2 find the weight:

10687.72 X .2836 = 3031.03 lbs

Answer: 3031 pounds

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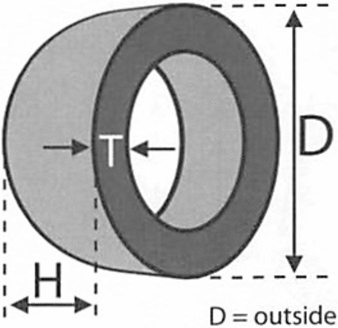
Volume: Pipe

① Determine the volume of the object

VOLUME = T × (D-T) × 3.141 × H

② Determine the approximate weight of the object

WEIGHT = Volume × Weight (per Cu)



D = outside diameter
H = overall length of pipe
T = wall thickness

EXAMPLE:

D = 18 inches
T = 1.5 inches
H = 48 inches

Material: Steel

Step 1 find the volume:

1.5 × (18 -1.5) × 3.141 × 48 = 3731.5 Cu in

Step 2 find the weight:

3731.5 × .2836 = 1058.25 lbs

Answer: 1058 pounds

SLINGS
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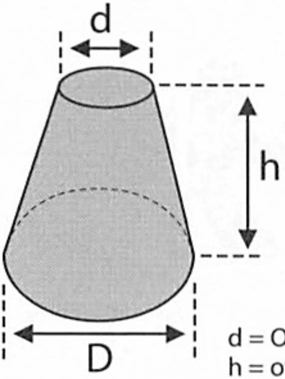
Volume: Frustum of a Cone

① Determine the volume of the object

VOLUME = $0.2618 \times h \times (D^2 + D \times d + d^2)$

② Determine the approximate weight of the object

WEIGHT = Volume × Weight (per Cu)



d = OD of small end
h = overall length
D = OD of large end

EXAMPLE:

d = 6 inches
D = 18 inches
h = 32 inches

Material: Steel

Step 1 find the volume:

$0.2618 \times 32 \times ((18\times18)+(18\times6)+(6\times6)) = 3920.71$ Cu in

also expressed as: $0.2618 \times 32 \times (468) = 3920.71$ Cu in

Step 2 find the weight:

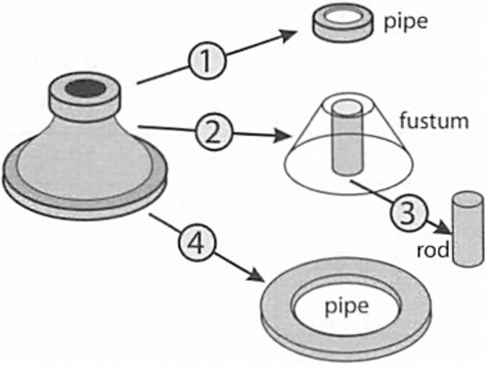
$3920.71 \times .2836 = 1111.91$ lbs

Answer: 1112 pounds

The four shapes covered on the previous pages will allow you to determine the approximate weight of almost any object. For example examine the illustration of a valve bonnet below, notice that if you visualize it as separate shapes you can easily determine its approximate weight. When in doubt, estimate on the HIGH side.
It is always better to OVER RIG than UNDER RIG

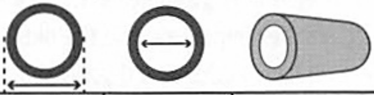
The following applies to the illustration shown below:

1.) a round & hollow object
2.) a frustum of a cone
3.) Is the hole in the center
(figure the hole as a solid round shape, then subtract its weight from the fustum.)
4.) also considered round & hollow



Remember, establishing the weight of an object is one of the most important steps in determining what type of rigging equipment to use for a safe lift!

Schedule 40 pipe



Nominal Size	OD	ID	Weight per foot
1/2"	0.840	0.622	0.851
3/4"	1.050	0.824	1.131
1"	1.315	1.049	1.679
1-1/4"	1.660	1.380	2.273
1-1/2"	1.900	1.610	2.718
2"	2.375	2.067	3.653
2-1/2"	2.875	2.469	5.793
3"	3.500	3.068	7.576
3-1/2"	4.000	3.548	9.109
4"	4.500	4.026	10.79
4-1/2"	5.000	4.506	12.53
5"	5.563	5.047	14.62
6"	6.625	6.065	18.970
8"	8.625	7.981	28.550
10"	10.750	10.020	40.480
12"	12.750	11.938	49.560
14"	14.000	13.124	63.440
16"	16.000	15.000	82.770

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Schedule 80 pipe

Nominal Size	OD	ID	Weight per foot
1/2"	0.840	0.546	1.09
3/4"	1.050	0.742	1.47
1"	1.315	0.957	2.17
1-1/4"	1.660	1.278	3.00
1-1/2"	1.900	1.500	3.63
2"	2.375	1.939	5.02
2-1/2"	2.875	2.323	7.66
3"	3.500	2.900	10.25
3-1/2"	4.000	3.364	12.50
4"	4.500	3.826	14.98
4-1/2"	5.000	4.290	17.61
5"	5.563	4.813	20.78
6"	6.625	5.761	28.57
8"	8.625	7.625	43.39
10"	10.750	9.750	64.43
12"	12.750	11.376	88.63
14"	14.000	12.500	106.13
16"	16.000	15.000	136.61

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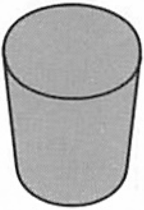
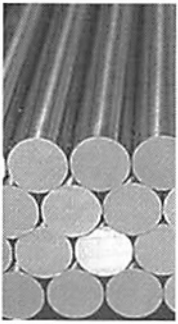
Solid Round Stock





Diameter	Weight per foot
1/2"	0.668
3/4"	1.502
1"	2.670
1-1/4"	4.173
1-1/2"	6.008
2"	10.680
2-1/2"	16.690
3"	24.03
3-1/2"	32.710
4"	42.730
4-1/2"	54.080
5"	66.760
6"	96.130
7"	130.800
8"	170.900
9"	216.300
10"	267.000

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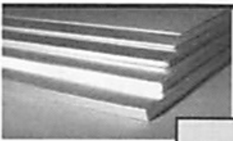
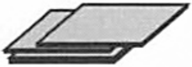
Sheet of steel (sq. ft.)





Thickness	lbs. per sq. ft.
3/16"	7.66
1/4"	10.21
5/16"	12.76
3/8"	15.32
7/16"	17.87
1/2"	20.42
9/16"	22.97
5/8"	25.53
11/16"	28.08
3/4"	30.63
7/8"	35.74
1"	40.84
2"	81.68
3"	122.52
4"	163.36
5"	204.2
6"	245.04
7"	285.88
8"	326.72

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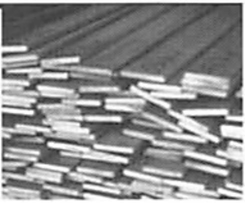
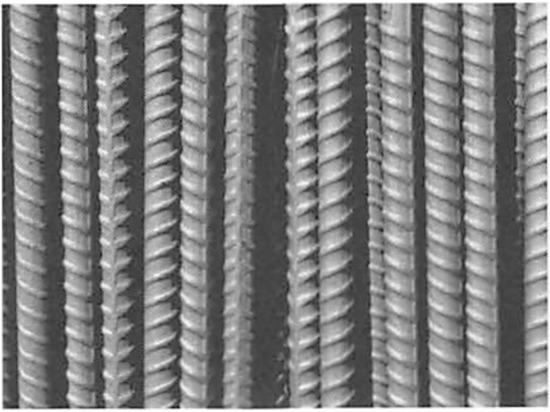
Steel strip stock



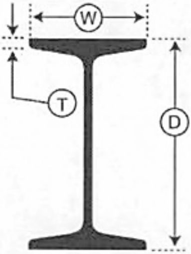
	Thickness			
	Weight per foot			
Width	1/4"	3/8"	1/2"	3/4"
1"	0.85	1.28	1.70	2.55
2"	1.70	2.55	3.40	5.10
3"	2.55	3.83	5.10	7.65
4"	3.40	5.10	6.80	10.20
5"	4.25	6.38	8.50	12.75
6"	5.10	7.65	10.20	15.30
7"	5.95	8.93	11.90	17.85
8"	6.80	10.20	13.60	20.40

Rebar



Bar No.	Diameter (inches)	Weight per foot
3	0.375	0.376
4	0.500	0.668
5	0.625	1.043
6	0.750	1.502
7	0.875	2.044
8	1.000	2.670
9	1.128	3.400
10	1.270	4.303
11	1.410	5.313
14	1.693	7.650
18	2.257	13.600

Steel S-type I-beams



		Dimensions		
Section number	Wt. Per foot (lbs)	D	W	T
S4	7.7	4	2 5/8	5/16
	9.5	4	2 3/4	5/16
S5	10	5	3	5/16
S6	12.5	6	3 3/8	3/8
	17.25	6	3 5/8	3/8
S7	15.3	7	3 5/8	3/8
S8	18.4	8	4	7/16
	23	8	4 1/8	7/16
S10	25.4	10	4 5/8	1/2
	35	10	5	1/2
S12	31.8	12	5	9/16
	35	12	5 1/8	9/16
	40.8	12	5 1/4	11/16
	50	12	5 1/2	11/16

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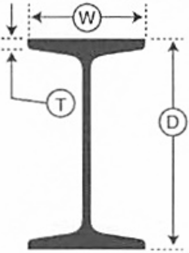
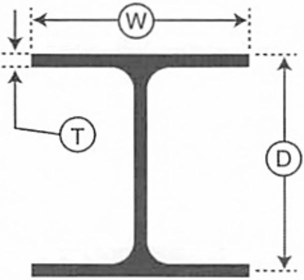
Steel S-type I-beams



Section number	Wt. Per foot (lbs)	Dimensions D	Dimensions W	Dimensions T
S15	42.9	15	5 1/2	5/8
	50	15	5 5/8	5/8
S18	54.7	18	6	11/16
	70	18	6 1/4	11/16
S20	66	20	6 1/4	13/16
	75	20	6 3/8	13/16
	86	20 1/4	7	15/16
	96	20 1/4	7 1/4	15/16
S24	80	24	7	7/8
	90	24	7 1/8	7/8
	100	24	7 1/4	7/8
	106	24 1/2	7 7/8	1 1/16
	121	24 1/2	8	1 1/16

Graphics ©2012 Jerry Klinke

Wide Flange I-beams



		Dimensions		
Section number	Wt. Per foot (lbs)	D	W	T
W8	10	7 7/8	4	3/16
	15	8 1/8	4	5/16
	18	8 1/8	5 1/4	5/16
	21	8 1/4	5 1/4	3/8
	24	7 7/8	6 1/2	3/8
	31	8	8	7/16
W10	12	9 7/8	4	3/16
	22	10 1/8	5 3/4	3/8
	26	10 3/8	5 3/4	7/16
	30	10 1/2	5 3/4	1/2
	33	9 3/4	8	7/16
	49	10	10	9/16

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SLINGS
HARDWARE
FORMULAS
WEIGHTS
OPERATIONS
STANDARDS
HAND SIGNALS

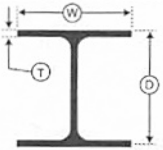
Wide Flange I-beams continued...

		Dimensions		
Section number	Wt. Per foot (lbs)	D	W	T
W12	14	11 7/8	4	1/4
	22	12 1/4	4	7/16
	26	12 1/4	6 1/2	3/8
	35	12 1/2	6 1/2	1/2
	40	12	8	1/2
	45	12	8	9/16
	53	12	10	9/16
	65	12 1/8	12	5/8
W14	22	13 3/4	5	5/16
	26	13 7/8	5	7/16
	30	13 7/8	6 3/4	3/8
	38	14 1/8	6 3/4	1/2
	43	13 5/8	8	1/2
	48	13 3/4	8	5/8
	53	13 7/8	8	11/16
	61	13 7/8	10	5/8
	82	14 1/4	10 1/8	7/8
	90	14	14 1/2	11/16

Wide Flange I-beams continued...

		Dimensions		
Section number	Wt. Per foot (lbs)	D	W	T
W16	26	15 3/4	5 1/2	3/8
	36	15 7/8	7	7/16
	45	16 1/8	7	9/16
	50	16 1/4	7 1/8	5/8
	57	16 3/8	7 1/8	11/16
	67	16 3/8	10 1/4	11/16
	77	16 1/2	10 1/4	3/4
	89	16 3/4	10 3/8	7/8
	100	17	10 3/8	1
W18	35	17 3/4	6	7/16
	40	17 7/8	6	1/2
	50	18	7 1/2	9/16
	60	18 1/4	7 1/2	11/16
	65	18 3/8	7 5/8	3/4
	71	18 1/2	7 5/8	13/16
	76	18 1/4	11	11/16
W21	44	20 5/8	6 1/2	7/16
	62	21	8 1/4	5/8
	73	21 1/4	8 1/4	3/4
	83	21 3/8	8 3/8	13/16
	93	21 5/8	8 3/8	15/16
	101	21 3/8	12 1/4	13/16

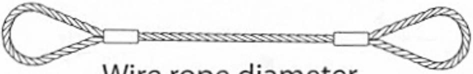
Wide Flange I-beams continued...



		Dimensions		
Section number	Wt. Per foot (lbs)	D	W	T
W24	55	23 5/8	7	1/2
	68	23 3/4	9	9/16
	84	24 1/8	9	3/4
	94	24 1/4	9 1/8	7/8
	104	24	12 3/4	3/4
	131	24 1/2	12 7/8	15/16
	146	24 3/4	12 7/8	1 1/16
	162	25	13	1 1/4
W27	84	26 3/4	10	5/8
	94	26 7/8	10	3/4
	102	27 1/8	10	13/16
	114	27 1/4	10 1/8	15/16
	146	27 3/8	14	1
	161	27 5/8	14	1 1/16
W30	124	30 1/8	10 1/2	15/16
	132	30 1/4	10 1/2	1
	148	30 5/8	10 1/2	1 3/16

Weight Estimator

Estimated weight of single part wire rope slings with pressed mechanical type sleeve connectors.



Sling Length in feet

Wire rope diameter

	3/4"	1"	1-1/2"	2"	2-1/2"	3"	3-1/2"	4"
10	16	30	78	156	▨	▨	▨	▨
15	22	40	98	193	342	▨	▨	▨
20	27	49	119	230	400	600	▨	▨
25	32	58	140	267	458	683	1,024	▨
30	37	67	161	304	516	766	1,137	1,621
35	42	77	182	341	574	849	1,251	1,769
40	48	86	202	378	632	932	1,364	1,917
45	53	95	223	415	690	1,015	1,478	2,065
50	58	104	244	452	748	1,098	1,591	2,213
55	63	114	265	489	806	1,181	1,705	2,361
60	68	123	286	526	864	1,264	1,818	2,509
65	74	132	306	563	922	1,347	1,932	2,657
70	79	141	327	600	980	1,430	2,045	2,805
75	84	151	348	637	1,038	1,513	2,159	2,953
80	89	160	369	674	1,096	1,596	2,272	3,101
85	94	169	390	711	1,154	1,679	2,386	3,249
90	100	178	410	748	1,212	1,762	2,499	3,397
95	105	188	431	785	1,270	1,845	2,613	3,545
100	110	197	452	821	1,328	1,928	2,726	3,693

weights shown are in lbs

Shackle Weight Estimator

Size		Weight
3/4"	Estimated weights – contact manufacturer for exact weight of each size shackle.	3 lbs
7/8"		4 lbs
1"		6 lbs
1-1/4"		12 lbs
1-1/2"		21 lbs
1-3/4"		34 lbs
2"		53 lbs
2-1/2"		99 lbs
3"		154 lbs
3-1/2"		265 lbs
4"		338 lbs

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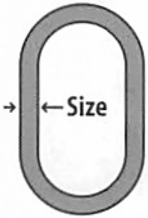
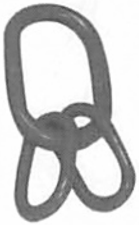
Weight Estimator

Oblong master links



Size	Approx. Weight (lbs)
3/4"	3
1"	5
1-1/4"	9
1-1/2"	16
1-3/4"	26
2"	38
2-1/4"	54
2-1/2"	58
2-3/4"	95
3"	110
3-1/4"	145
3-1/2"	200

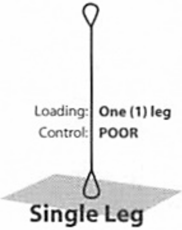


CM oblong master link sub-assembly

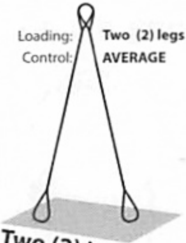
Master link	Sub-link	wt (lb)
1/2"	11/32"	1
3/4"	15/32"	2.6
1"	21/32"	6.1
1-1/4"	29/32"	13.3
1-1/2"	1-5/32"	24.3
1-3/4"	1-9/32"	36.1
2"	1-17/32"	57.4
2-1/4"	1-25/32"	83.9
2-3/4"	2-1/32"	129.7

Graphics ©2012 Jerry Klinke

Hitches / Load Control

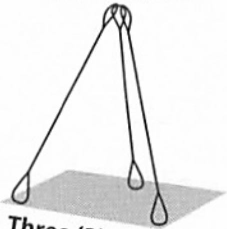

Loading: One (1) leg
Control: POOR

Single Leg


Loading: Two (2) legs
Control: AVERAGE

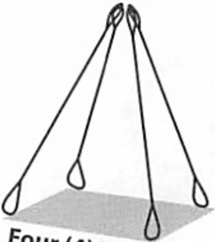
Two (2) Legs

Loading: Three (3) legs
Control: VERY GOOD

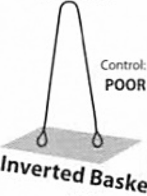


Three (3) Legs

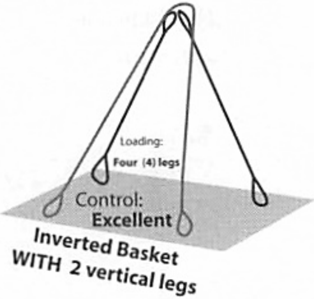
Loading: Two (2) legs
Control: VERY GOOD



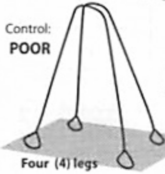
Four (4) Legs


Two (2) legs
Control:
POOR

Inverted Basket


Loading:
Four (4) legs
Control:
Excellent

Inverted Basket
WITH 2 vertical legs


Control:
POOR
Four (4) legs

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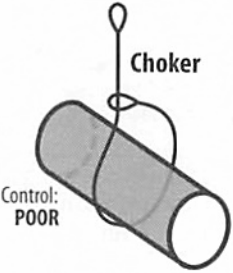
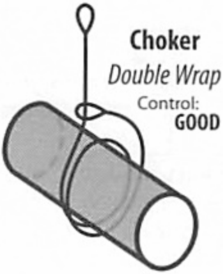
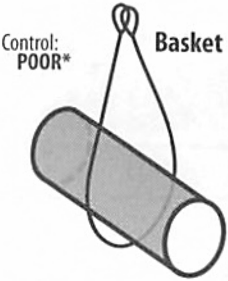
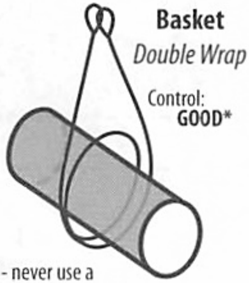
Hitches / Load Control

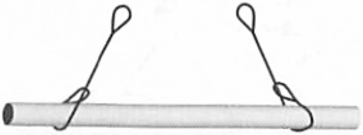

Choker
Control:
POOR


Choker
Double Wrap
Control:
GOOD

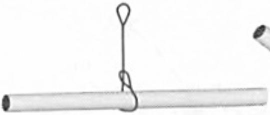

Control:
POOR*
Basket

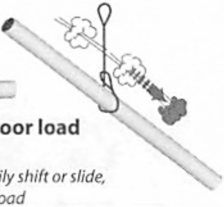

Basket
Double Wrap
Control:
GOOD*

* ONLY if more than one sling is used - never use a basket hitch with only ONE sling!



2 slings = better load control





Single choker hitch = Poor load control

Since the load can move, it can easily shift or slide, resulting in a dropped load

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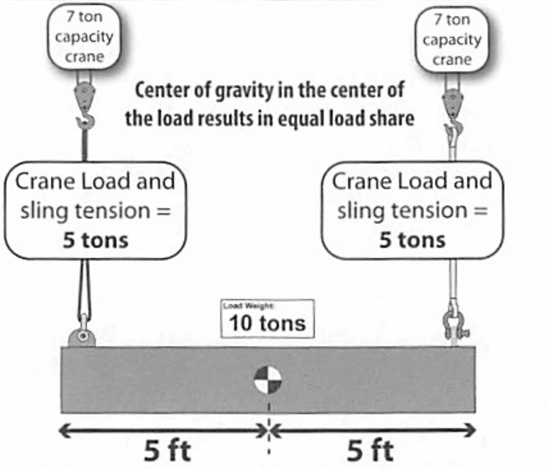
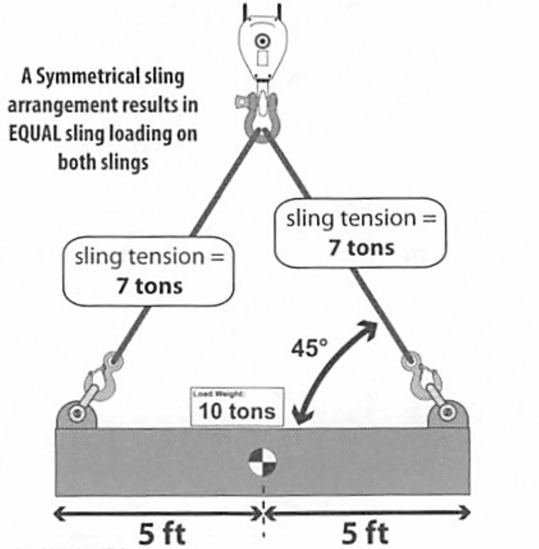
Symmetrical Loads



Center of gravity in the center of the load results in equal load share

7 ton capacity crane
7 ton capacity crane
Crane Load and sling tension = **5 tons**
Crane Load and sling tension = **5 tons**
Load Weight:
10 tons
5 ft
5 ft

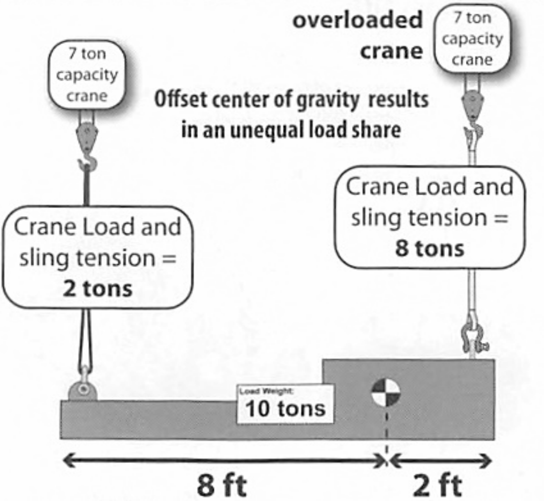


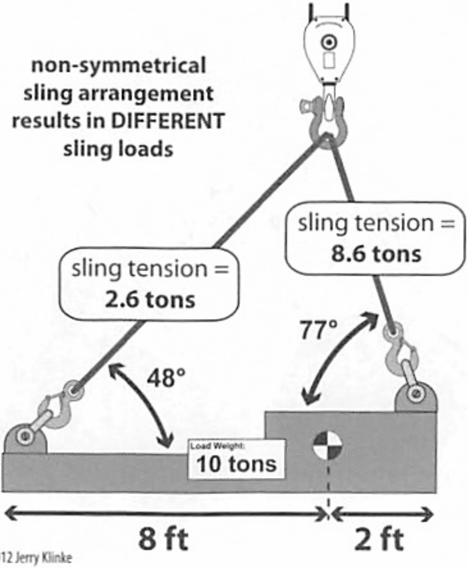
A Symmetrical sling arrangement results in EQUAL sling loading on both slings

sling tension = **7 tons**
sling tension = **7 tons**
45°
Load Weight:
10 tons
5 ft
5 ft

Graphics ©2012 Jerry Klinke

Non-symmetrical Loads


overloaded crane
7 ton capacity crane
7 ton capacity crane
Offset center of gravity results in an unequal load share
Crane Load and sling tension = **8 tons**
Crane Load and sling tension = **2 tons**
Load Weight:
10 tons
8 ft
2 ft


non-symmetrical sling arrangement results in DIFFERENT sling loads
sling tension = **8.6 tons**
sling tension = **2.6 tons**
77°
48°
Load Weight:
10 tons
8 ft
2 ft

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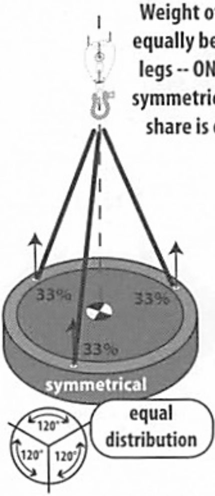
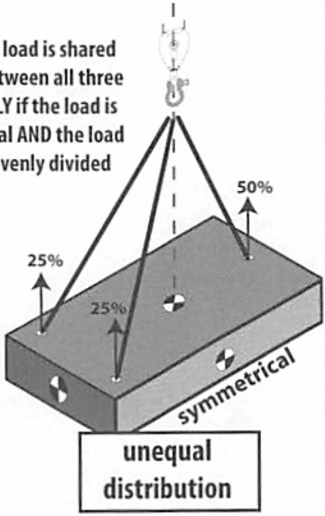
Hitches / Load Control

Three Point Lifts

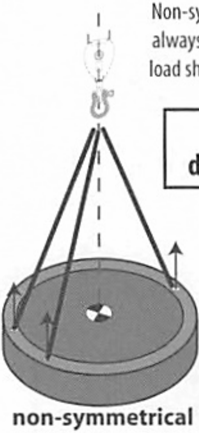

33%
33%
33%
symmetrical
120°
120°
120°
equal distribution

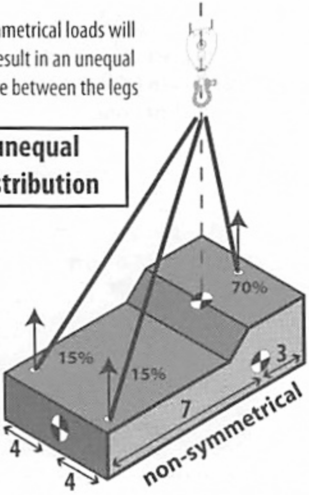
Weight of load is shared equally between all three legs -- ONLY if the load is symmetrical AND the load share is evenly divided


50%
25%
25%
symmetrical
unequal distribution

Non-symmetrical loads will always result in an unequal load share between the legs

unequal distribution

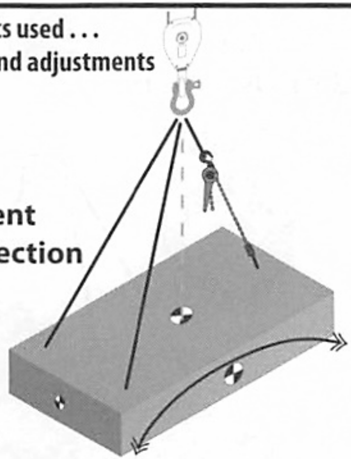

non-symmetrical


70%
15%
15%
3
7
4
4
non-symmetrical

Graphics ©2012 Jerry Klinke

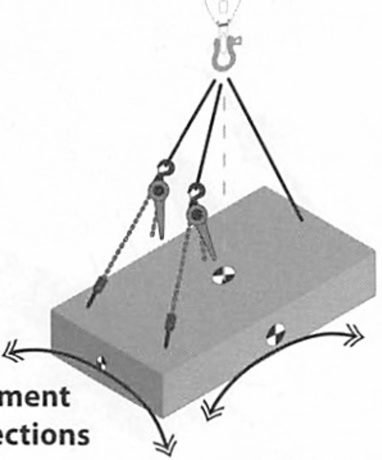
Hitches / Load Control

Three Point Lifts used . . .
for leveling and adjustments



Adjustment in only 1 direction

3 lifting points provide the best configuration for leveling - **provided that 2 or more legs are adjustable.**



Adjustment in 2 directions

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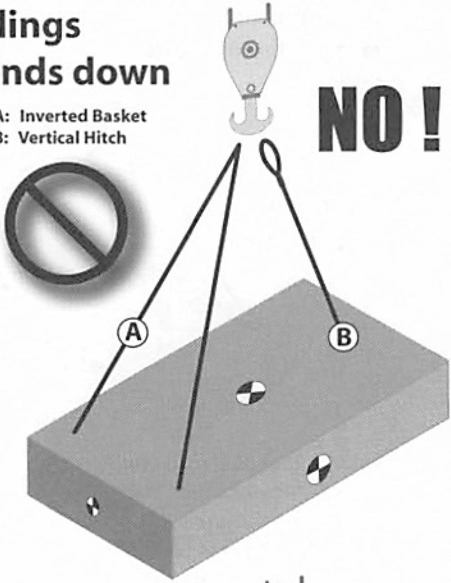
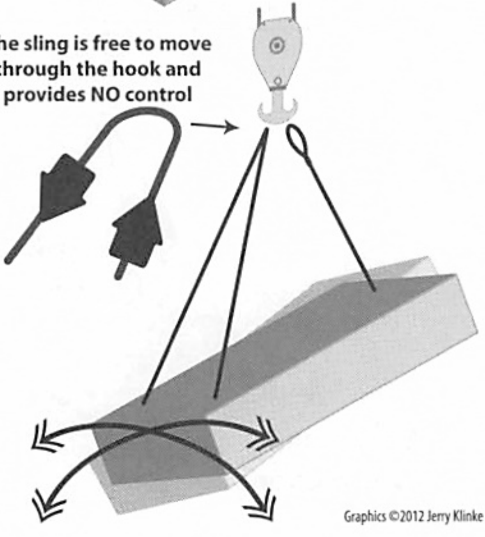
Hitches / Load Control

2 slings
3 ends down

Sling A: Inverted Basket
Sling B: Vertical Hitch





The sling is free to move through the hook and provides NO control

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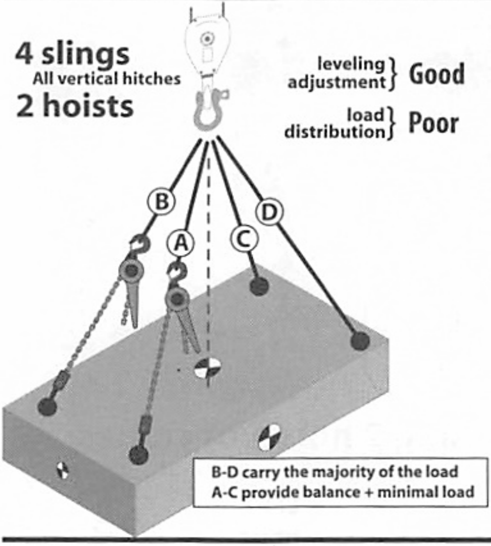
Hitches / Load Control

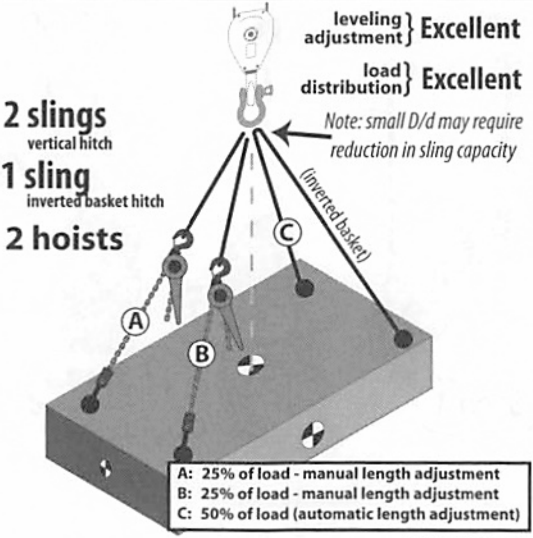


4 slings
All vertical hitches
2 hoists

leveling adjustment } **Good**

load distribution } **Poor**

B-D carry the majority of the load
A-C provide balance + minimal load



leveling adjustment } **Excellent**

load distribution } **Excellent**

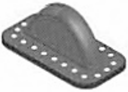
Note: small D/d may require reduction in sling capacity

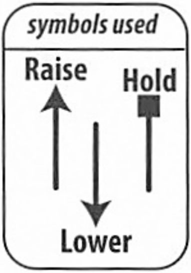
2 slings
vertical hitch
1 sling
inverted basket hitch
2 hoists

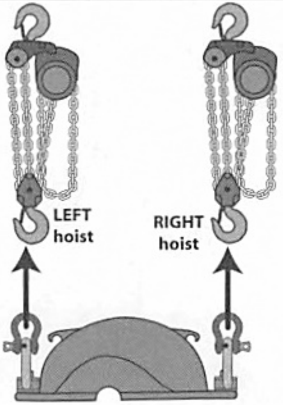
A: 25% of load - manual length adjustment
B: 25% of load - manual length adjustment
C: 50% of load (automatic length adjustment)

Graphics ©2012 Jerry Klinke

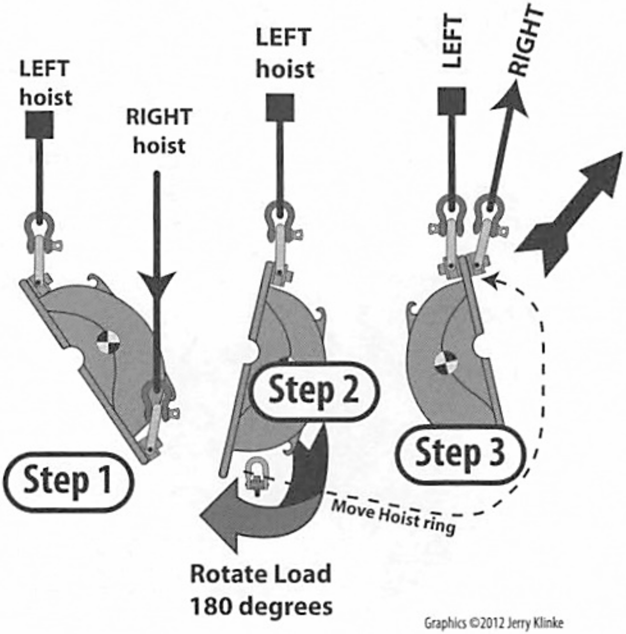
Turning Loads




symbols used
Raise
Hold
Lower

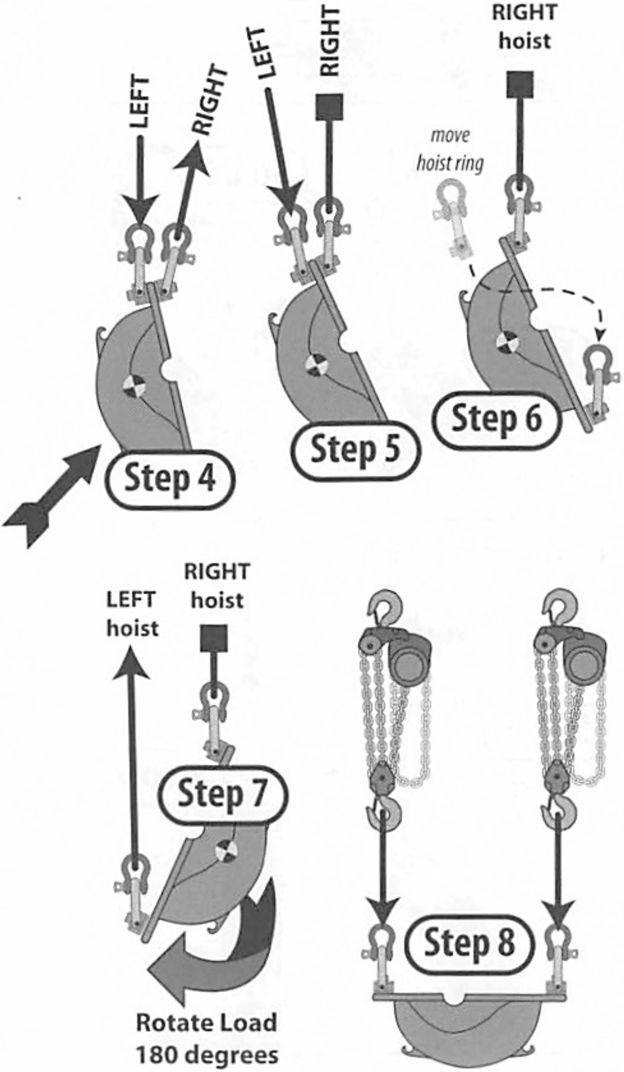

LEFT
hoist
RIGHT
hoist

Using 2 hoists or cranes


LEFT
hoist
RIGHT
hoist
Step 1
LEFT
hoist
Step 2
Move Hoist ring
Rotate Load
180 degrees
LEFT
RIGHT
Step 3

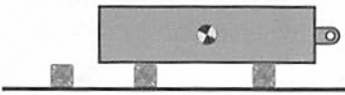
Graphics ©2012 Jerry Klinke

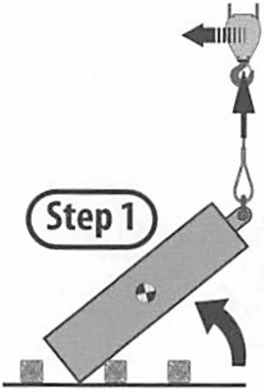
Turning Loads

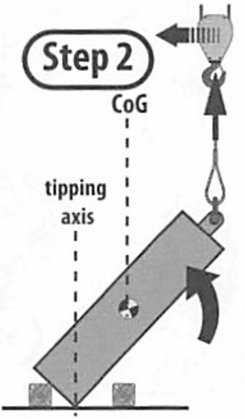

LEFT
RIGHT
Step 4
LEFT
RIGHT
Step 5
RIGHT
hoist
move
hoist ring
Step 6
LEFT
hoist
RIGHT
hoist
Step 7
Rotate Load
180 degrees
Step 8

Graphics ©2012 Jerry Klinke

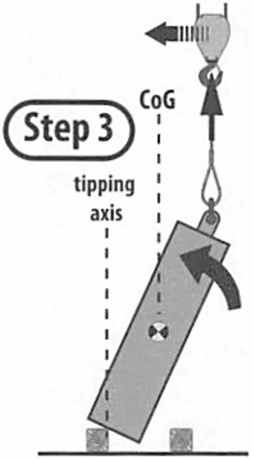
Turning Loads

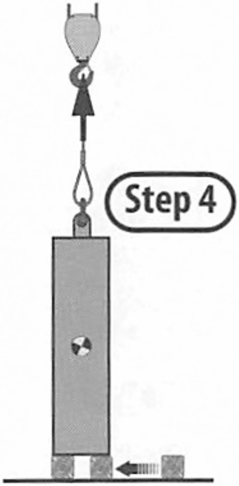





Step 2
CoG
tipping
axis

Using 1 crane

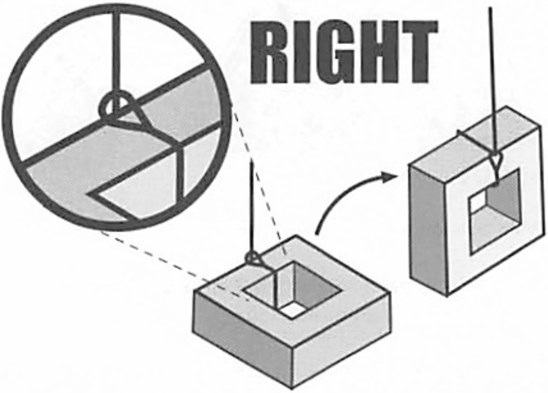

Step 3
CoG
tipping
axis



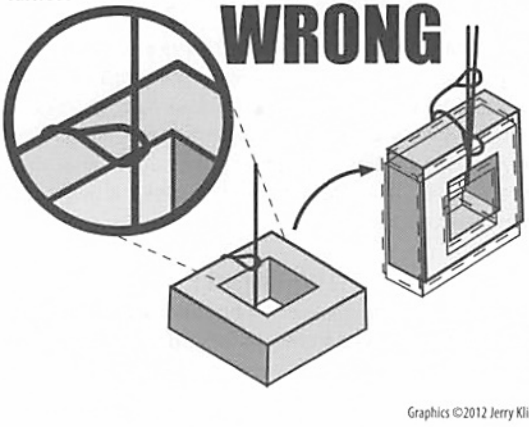
Graphics ©2012 Jerry Klinke

Turning Loads

When turning with a choker hitch, it is extremely important to remember that the eye of the cable must be placed so it faces in the opposite direction of the turn. If this is not done, the load will be turned in a loose cable.

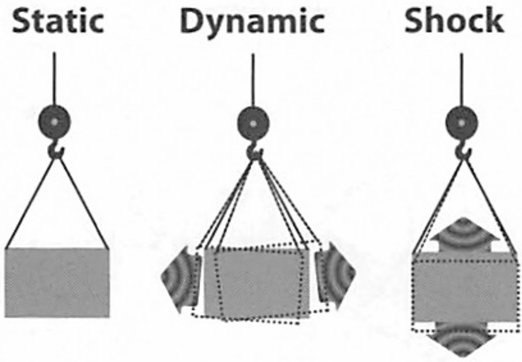


Remember that the capacity of the sling will be reduced because of the "tight" choke angle formed when the load is turned.



Graphics ©2012 Jerry Klinke

Shock Loading


Static Dynamic Shock

When the load is suspended and not moving it is called a **static load.**

When the load begins to move, additional stresses are imposed on the rigging, this is called a **dynamic load.**

Shock Loads (considered a Dynamic load) act suddenly upon the rigging. Their effects can be quite disastrous because of the tremendous additional tension to the rigging. Unless the rigging was considerably larger than what was needed for the static load, failure of the rigging is possible.

When lifting a load, the crane hook should be started very slowly until the sling becomes taut. Then continue lifting slowly until the load is suspended. The speed with which you lift or lower the crane hook should increase or decrease gradually. Any sudden starts or stops place a much heavier load on the slings. How much the load is increased on the slings is impossible to tell. It could be from 2 times the actual load weight, or 100 times the actual load weight.

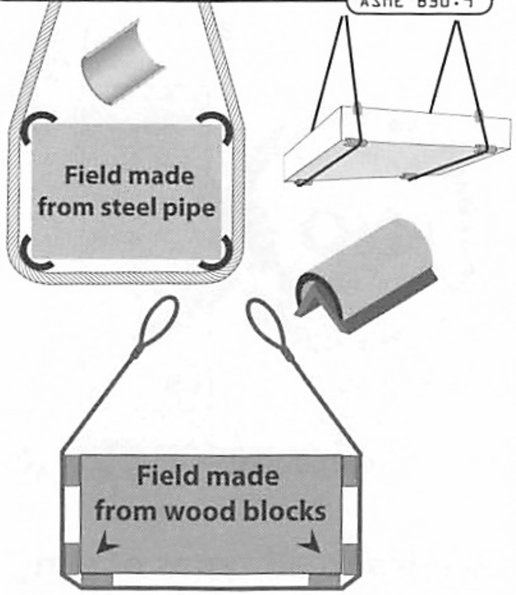
! WARNING !

Once any rigging equipment has been shock loaded it should be removed from service and re-evaluated for continued use.

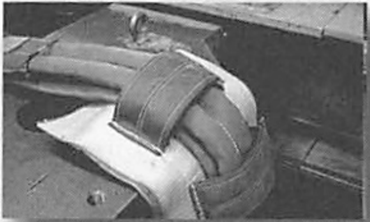
Graphics ©2012 Jerry Klinke

Softeners

> *"Sharp edges in contact with the sling should be padded with material of sufficient strength to protect the sling."*
>
> ASME B30.9

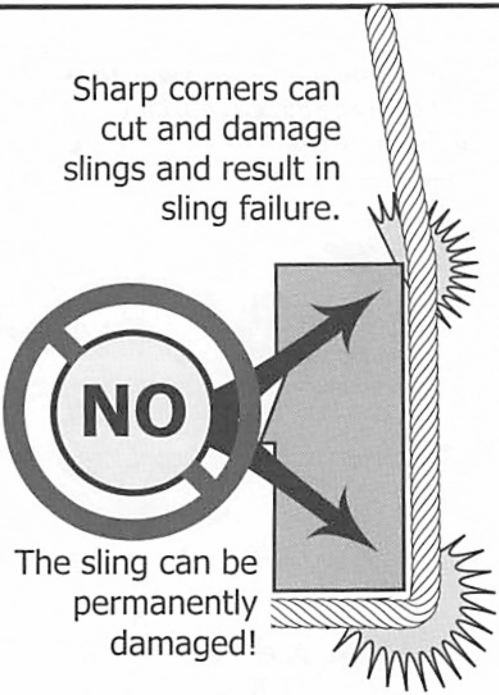

Field made
from steel pipe
Field made
from wood blocks

Commercially made



CornerMax® pads - www.slingmax.com

Softeners



Sharp corners can cut and damage slings and result in sling failure.

The sling can be permanently damaged!

Applies to all types of slings!

But synthetic slings especially need protection from load edges - even if the edge is not "razor" sharp.

An edge without adequate protection may result in a catastrophic sling failure.

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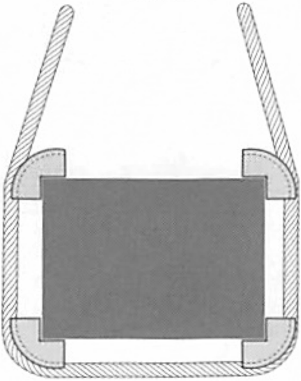
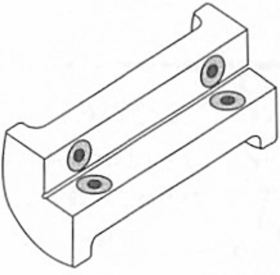
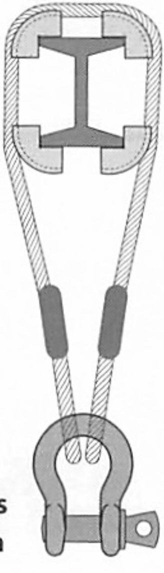
Softeners

Magnetic Corner Protectors



These magnetic edge protectors are made out of nylon and can be used with both synthetic and wire rope slings.



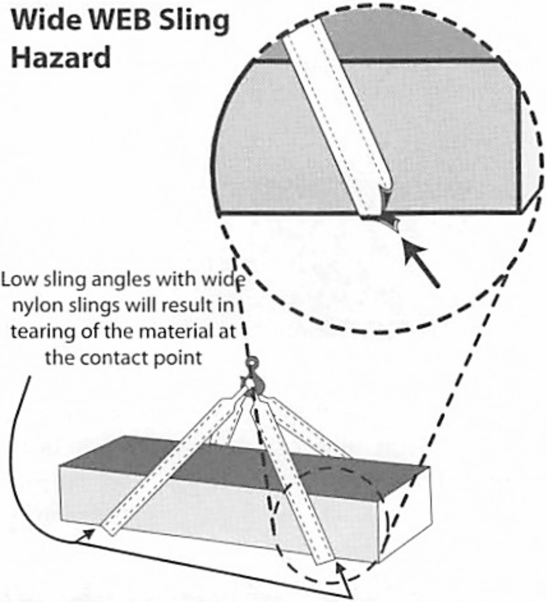


Linton Rigging Gear Supplies
www.lrgsupplies.com

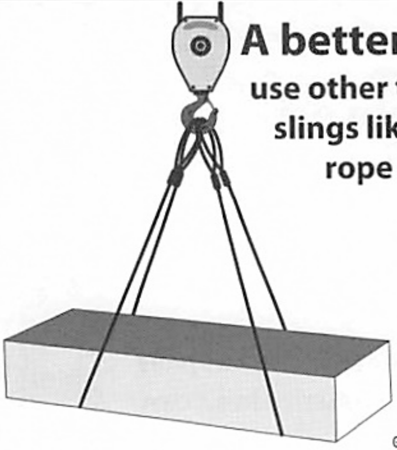
Graphics ©2012 Jerry Klinke

WEB Sling hazards

Wide WEB Sling Hazard



Low sling angles with wide nylon slings will result in tearing of the material at the contact point

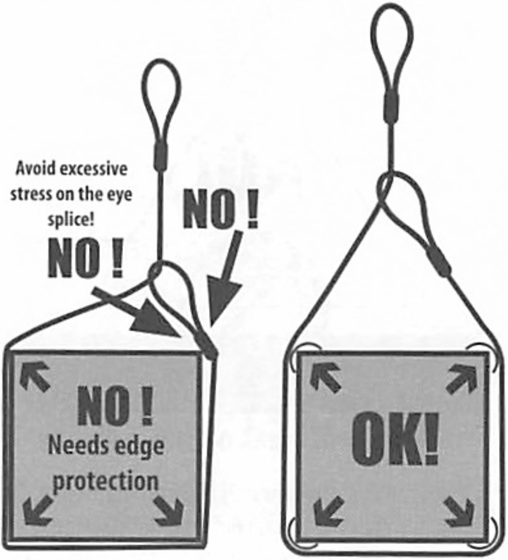


A better way!

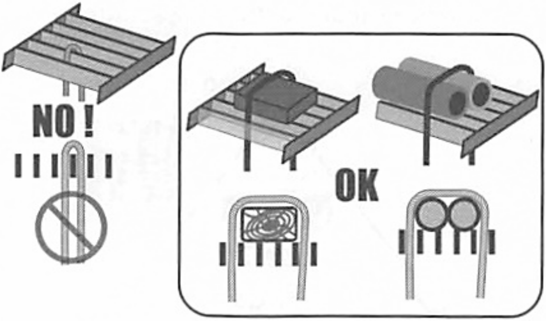
use other types of slings like wire rope . . .

Graphics ©2012 Jerry Klinke

Protect the slings . .

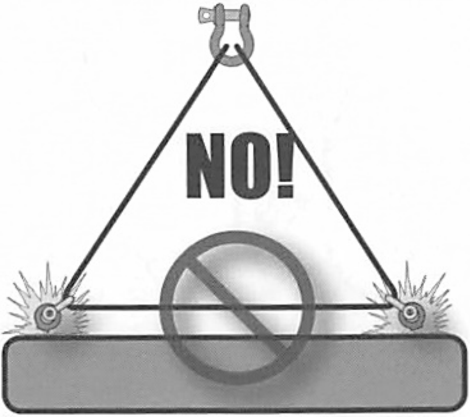

Avoid excessive stress on the eye splice!
NO !
NO !
NO !
Needs edge protection
OK!

IF you MUST rig from grading . . .



First, make sure the grading will structurally support the load (engineering analysis required) then use a piece of wood or pipe to distribute the load and protect the sling from damage against the sharp edges of the grading.

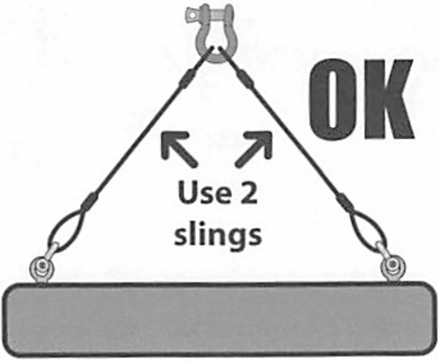
Reeving eyebolts



"reeving" will break off the eyebolts!

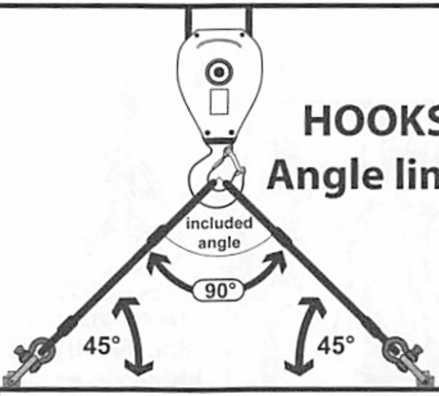
This illustration shows an extremely POOR rigging practice. By "reeving" a single sling through the eye bolts will immensely amplify the force on the eye bolts due to the resulting force.

Eyebolts will bend or break because of this tremendous force applied to them, this practice should ALWAYS be avoided!



Limits

HOOKS Angle limit

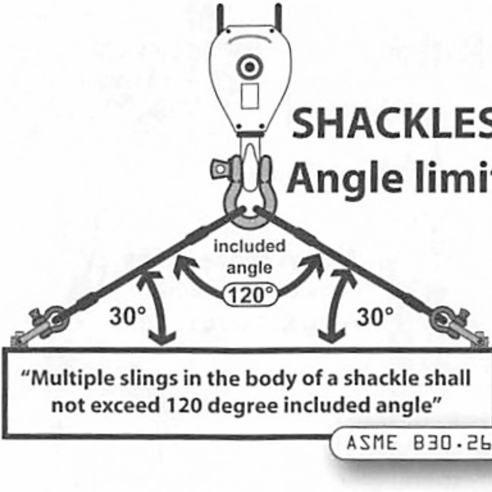

included
angle
90°
45°
45°

The recommended safe MAXIMUM included angle of a hook with 2 slings is 90°

ASME B30.10

Use a shackle when lower horizontal angles are encountered.

SHACKLES Angle limit

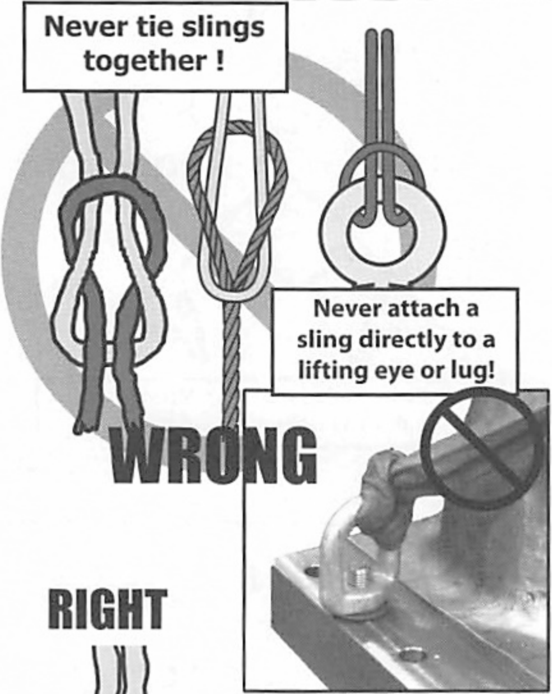

included
angle
120°
30°
30°

"Multiple slings in the body of a shackle shall not exceed 120 degree included angle"

ASME B30.26

Graphics ©2012 Jerry Klinke

Sling Connections

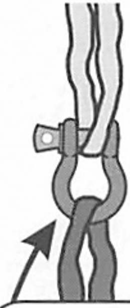


Never tie slings together !

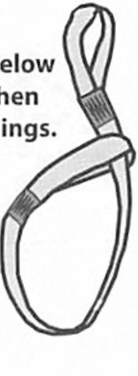
Never attach a sling directly to a lifting eye or lug!

WRONG

RIGHT



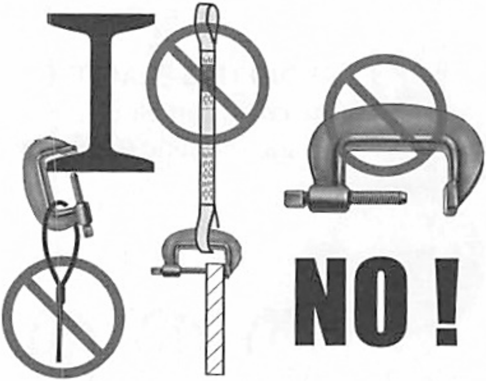
Use a shackle to connect them



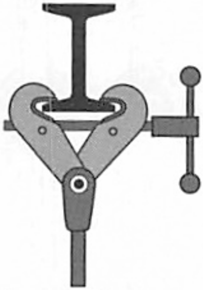
Always choke below the threads when using flat web slings.

Graphics ©2012 Jerry Klinke

Bad rigging practices



C-Clamps should NEVER be used for overhead lifting applications!



Beam Clamp

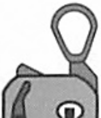
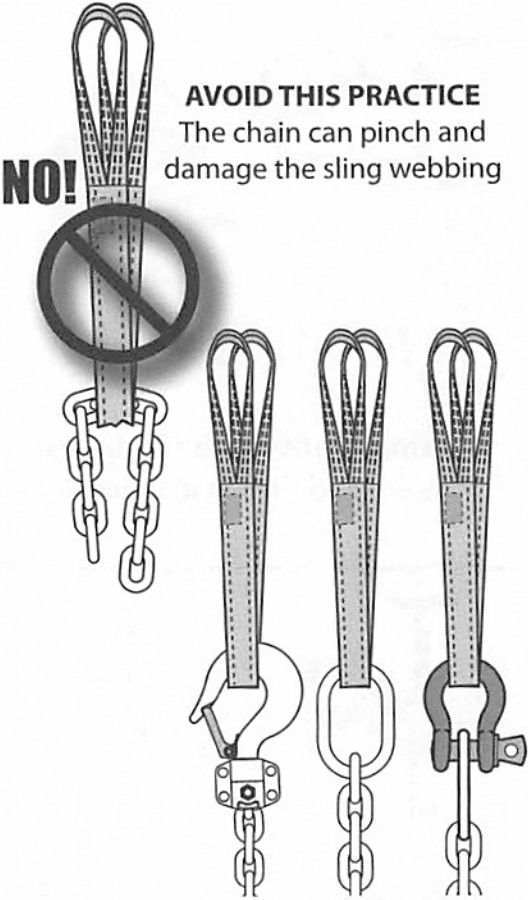


Plate Lifting Clamp

Use the proper lifting devices that are rated and approved for this type of lifting.

Graphics ©2012 Jerry Klinke

Sling connections

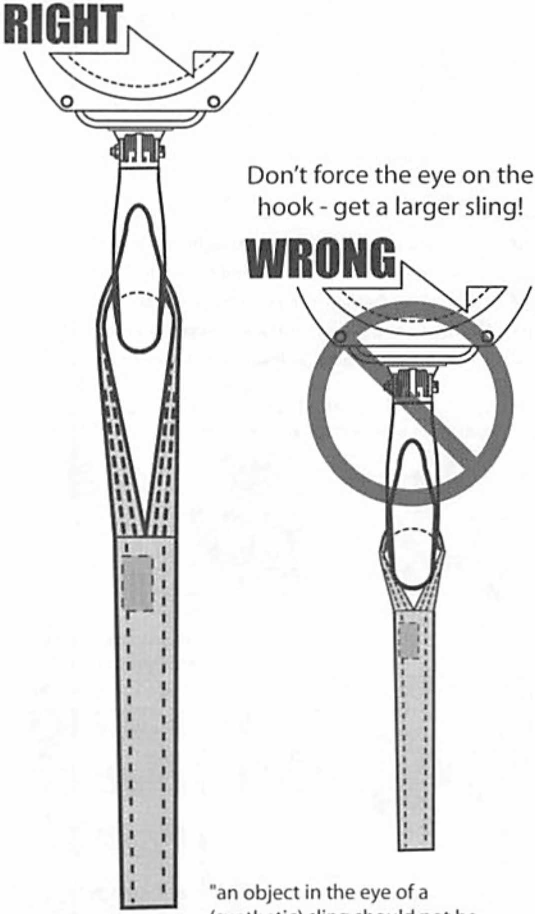


AVOID THIS PRACTICE
The chain can pinch and
damage the sling webbing

There are better ways to attach chains to web slings. The hook or master link will provide a smooth surface that will not damage the web sling material.

Graphics ©2012 Jerry Klinke

Hooks



Don't force the eye on the hook - get a larger sling!

"an object in the eye of a (synthetic) sling should not be wider than one-half the length of the eye"

ASME B30.9

Graphics ©2012 Jerry Klinke

Cribbing

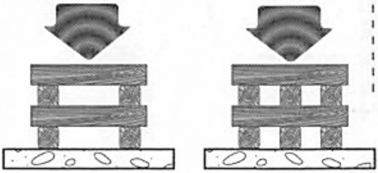
Cribbing strength is determined by figuring the surface area at each point of contact and multiplying by the compressive strength of the wood. **Douglas Fir is about 500 psi, Oak is around 1,200 psi.**

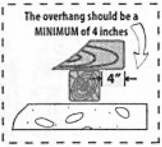
Examples for Douglas Fir: 4x4 wood is actually 3.5" x 3.5" (actual dimensions) so.. 3.5" x 3.5" = 12.25 sq. inches
12.25 sq in x 500 psi = 6,125 lbs. per contact point (lets use 6,000 lbs)
Total Capacity for 2 x 2 Crib = 4 x 6000 = 24,000 lbs
Total Capacity for 3 x 3 Crib = 9 x 6000 = 54,000 lbs

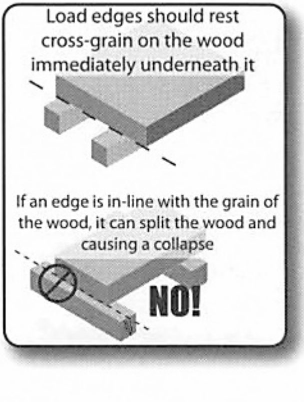
- ☑ **Select wood blocking that is straight and uniform**
- ☑ **Place edges across the grain and not with the grain**
- ☑ **Inspect for cracks, rotting or other defects**
- ☑ **Firm and solid ground surface to supporto the blocking**
- ☑ **The crib stack should be level before placing the load on it**

Crib Stability

Load must be centered on the crib arrangment



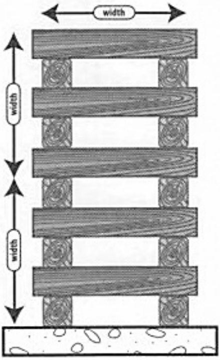

The overhang should be a MINIMUM of 4 inches
4"



Load edges should rest cross-grain on the wood immediately underneath it

If an edge is in-line with the grain of the wood, it can split the wood and causing a collapse

Height of cribbing should be limited to two times the width



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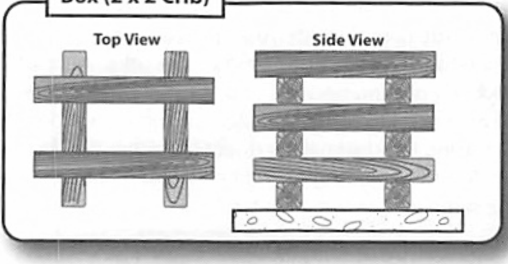
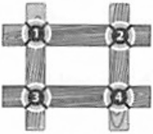
Cribbing

Box (2 x 2 Crib)





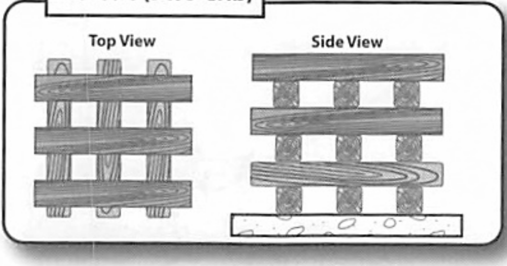
4 points of contact

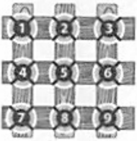
Maximum Support Capacity (in lbs)

Wood Size	Douglas Fir	Oak
4x4's	24,000	58,000
6x6's	60,000	145,000
8x8's	112,000	270,000
10x10's	180,000	430,000

Maximum Support Capacity , using FIR 4x4's stacked in a 2x2 crib would be 24,000 lbs

Crosstie (3 x 3 Crib)





9 points of contact

Maximum Support Capacity (in lbs)

Wood Size	Douglas Fir	Oak
4x4's	54,000	130,000
6x6's	135,000	325,000
8x8's	252,000	600,000
10x10's	405,000	970,000

Maximum Support Capacity , using FIR 4x4's stacked in a 3x3 crib would be 54,000 lbs

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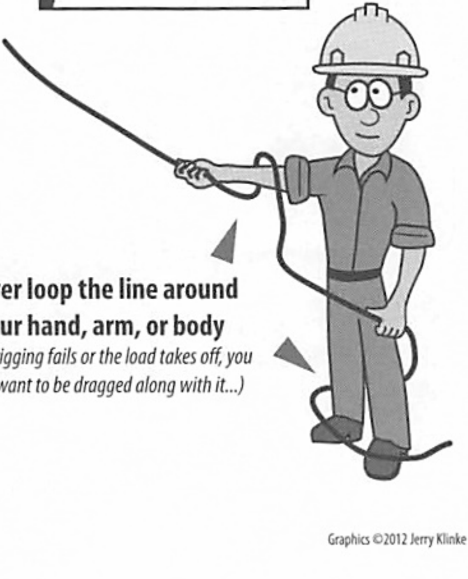
Taglines

Planned Tag Line Procedures:
With large complex lifts - using a planned tag line procedure makes the lift go very smoothly without anybody getting nervous or upset. One person should be able to control the complete tag line operation by just using hand signals to direct the other tag line tenders and in doing so will be able to maintain about the same tension on each tag line.

Large diameter ropes are easier to hold on to . .



Never loop the line around your hand, arm, or body

(if the rigging fails or the load takes off, you don't want to be dragged along with it...)

Graphics ©2012 Jerry Klinke

Tag lines can help keep a load under control - but remember, your weight is no match against a load that has started to swing and develop momentum!

There are no written rules that tell us how many tag lines should be used for lifted loads. As a rule of thumb - use as many as needed to adequately control the load.

Tag lines will . . .

1. keep you out of harm's way when guiding a suspended load into position
2. put distance between yourself and the load in the event the load moves unexpectedly
3. keep the load square and away from the crane boom during lifting operations
4. stabilizes the load and prevents rotation and swinging out of control

Tag lines should:

1. be made of a fiber material and non-conductive
2. be long enough to reach the ground from the highest point of the lift
3. be free of knots or defects in the rope (NO spliced together ropes)
4. be larger than 1/4" diameter - a large rope is easier to hold on to..

When tending tag lines:

1. Never loop the line around your hand, arm, or body
2. Always wear gloves (rope burns, better grip, etc.)
3. Make sure YOUR travel path is clear (you will be watching the load, rather than where you are going)

OSHA 1926.1408(b)(2) "If tag lines are used, they must be non-conductive"

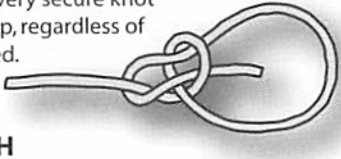
OSHA 1926.1417(w) "A tag or restraint line must be used if necessary to prevent rotation of the load that would be hazardous"

Basic Knots

IMPORTANT: These knots are for tag line ropes only! NEVER tie ANY knots in rigging gear used for industrial rigging and overhead lifting applications.

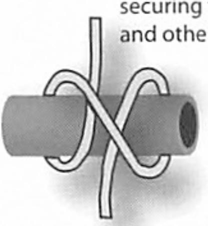
BOWLINE

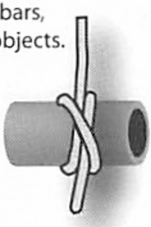
A bowline is a very secure knot which won't slip, regardless of the load applied.



CLOVE HITCH

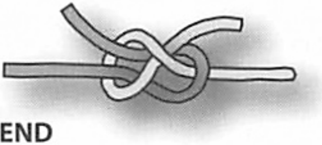
This is a popular knot for securing to posts, bars, and other round objects.





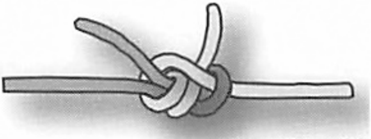
SHEET BEND

A useful knot for tying two ropes together, even if the rope sizes and materials differ greatly.



DOUBLE SHEET BEND

This knot provides greater security, especially in plastic rope. Its the same as the sheet bend but with an extra coil around the standing loop.



Graphics ©2012 Jerry Klinke

Basic Knots

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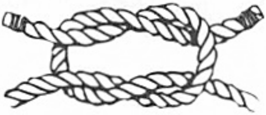
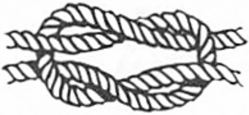
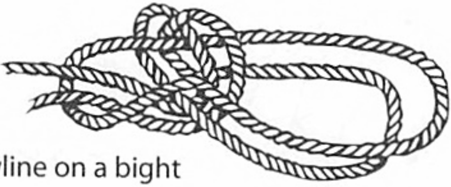


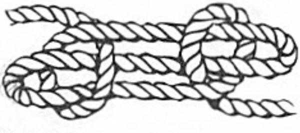
Square Knot



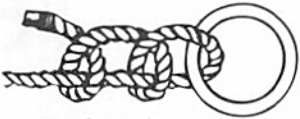
Granny Knot



Bowline on a bight



Sheepshank Knot



Two Half Hitches

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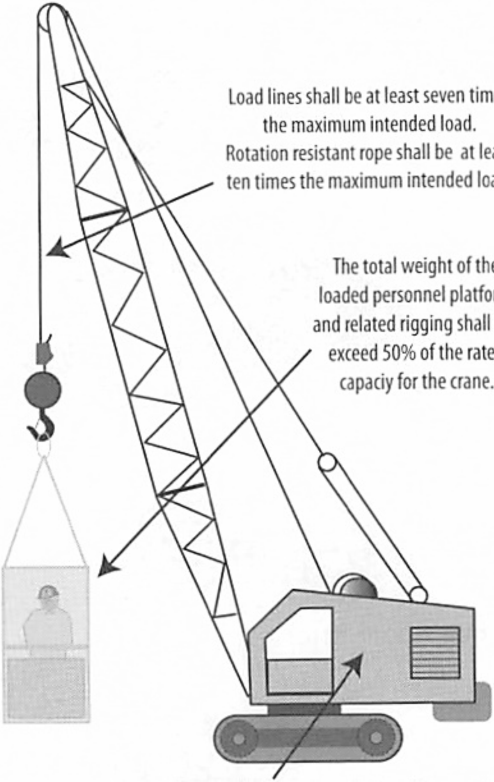
Personnel Platforms

This information provides **a generic, non-exhaustive overview** *of the OSHA standard on suspended personnel platforms. Standards and interpretations change over time, you should always check current requirements*

All the requirements are NOT shown here, refer to OSHA 1926.550 and ASME B30.23



Load lines shall be at least seven times the maximum intended load. Rotation resistant rope shall be at least ten times the maximum intended load.

The total weight of the loaded personnel platform and related rigging shall not exceed 50% of the rated capaciy for the crane.

All brakes and locking devices shall be engaged when the occupied personnel platform is in a stationary working position.

Cranes that have live booms are prohibited !

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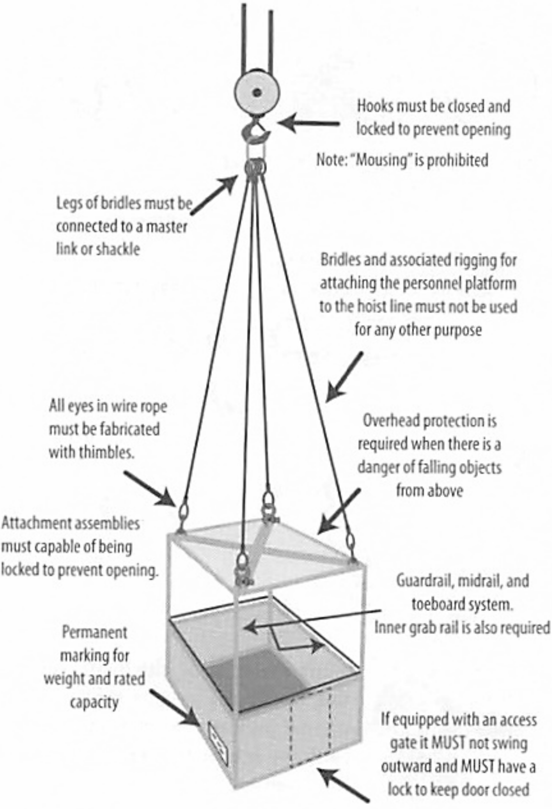
Personnel Platforms

This information provides **a generic, non-exhaustive overview** *of the OSHA standard on suspended personnel platforms. Standards and interpretations change over time, you should always check current requirements*

All the requirements are NOT shown here, refer to OSHA 1926.550 and ASME B30.23



Hooks must be closed and locked to prevent opening

Note: "Mousing" is prohibited

Legs of bridles must be connected to a master link or shackle

Bridles and associated rigging for attaching the personnel platform to the hoist line must not be used for any other purpose

All eyes in wire rope must be fabricated with thimbles.

Overhead protection is required when there is a danger of falling objects from above

Attachment assemblies must capable of being locked to prevent opening.

Guardrail, midrail, and toeboard system. Inner grab rail is also required

Permanent marking for weight and rated capacity

If equipped with an access gate it MUST not swing outward and MUST have a lock to keep door closed

Must be designed by a qualified engineer, or a qualified person competent in structural design, and fabricated and welded by a qualified welder.

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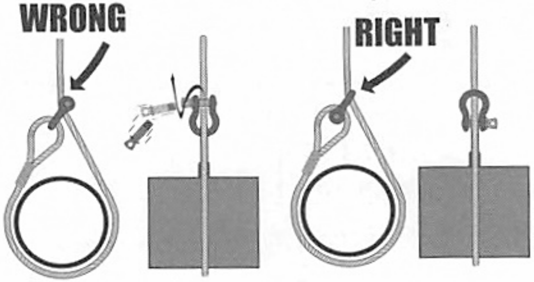
Rigging Practices

Operating Practices

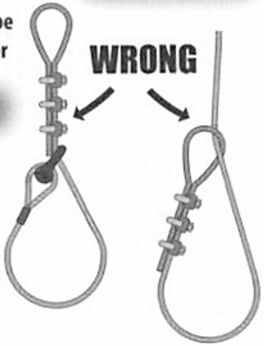

WRONG
RIGHT

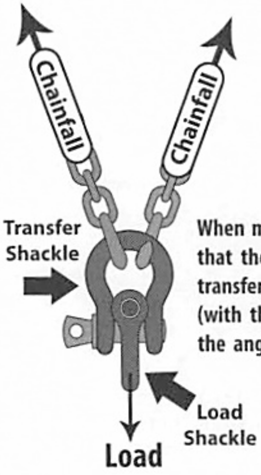
"When a shackle is used in a choker hitch, the pin shall be connected to the eye of the sling"

ASME B30.26

"Slings fabricated using wire rope clips shall not be used in a choker hitch."

ASME B30.9




Chainfall
Chainfall
Transfer Shackle
Load Shackle
Load

When moving loads with hoists, ensure that the shackle used on the hoists to transfer the loads is positioned correctly (with the bow of the shackle handling the angular tension)

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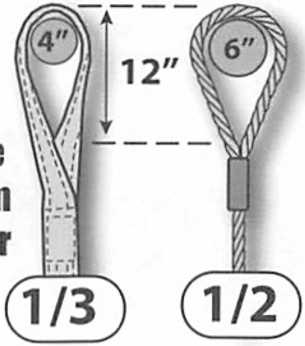
Rigging Practices

Sling Eye Maximum Diameter

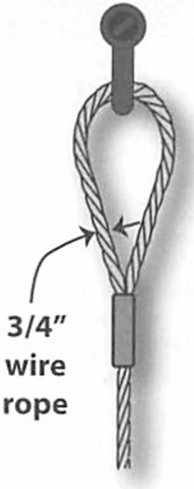


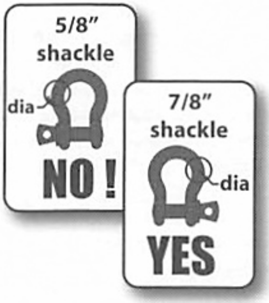
ASME B30.9-5.10.4(q) **WEB Slings:** "An object in the eye of a sling should not be wider than one-third the length of the eye"

ASME B30.9-2.10.4(q) **Wire Rope Slings:** "An object in the eye of a sling should not be wider than one half the length of the eye"

Sling Eye Minimum Diameter

ASME B30.9 "Wire Rope Slings . . . . NOT less than the nominal sling diameter"





Note: ASME does not list a minimum for WEB slings

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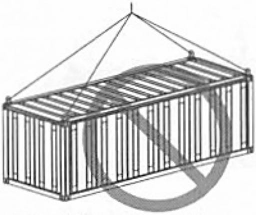
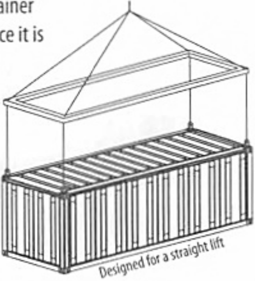
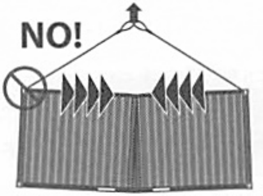
Shipping Containers

Designed for **vertical lifts only**, rigging from the TOP corners of a loaded container may cause the collapse of the box, since it is not designed for these forces.



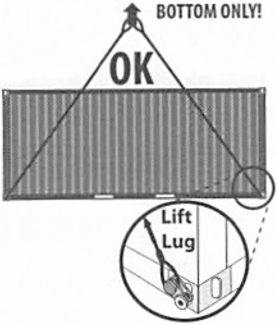

Designed for a straight lift

Lifting a FULL container this way, will collapse it!



EMPTY containers MAY be able to withstand these forces, check with the manufacturer.

Lift FULL containers from the BOTTOM ONLY!



An intermodal container (also known as; freight container, ISO container, shipping container, hi-cube container, box, conex box and sea can) is a standardized reusable steel box used for the efficient and secure storage and movement of materials and products within a global containerized intermodal freight transport system. "Intermodal" indicates that the container can be moved from one mode of transport to another (from ship, to rail, to truck) without unloading and reloading the contents of the container.

Lengths of these containers vary from 8-foot to 56-foot and have heights from 8-foot to 9-1/2 feet. Empty containers weigh about 5,000 pounds empty, and when loaded may weigh up to 45,000 pounds. It is, therefore, essential to observe the utmost safety precautions when moving or lifting empty or loaded cargo containers.

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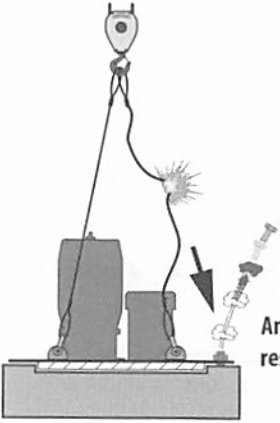
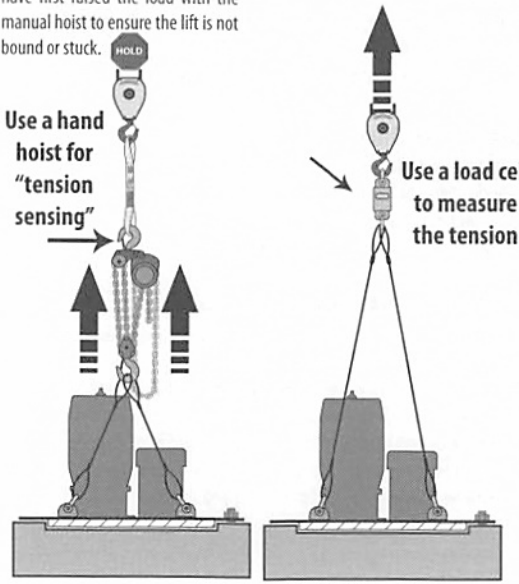
Rigging Practices



Any lift with the potential for being stuck can seriously overload the rigging and crane. Precautions should be taken to assure that the load is free and without any binding concerns.

An overlooked bolt can result in severe rigging overload

Don't lift with the crane until you have first raised the load with the manual hoist to ensure the lift is not bound or stuck.



Use a hand hoist for "tension sensing"

Use a load cell to measure the tension

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SLINGS
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OPERATIONS
STANDARDS
HAND SIGNALS

Lifting Operations

PRE-LIFT GUIDE

This is a general guide only and NOT a comprehensive list of all requirements

LOAD

_ Weight and center of gravity has been determined
_ Anything inside/outside the load that could shift during the lift?
_ Determine if the load needs protection against damage from the rigging
_ All anchor bolts, hold downs, or fasteners have been removed
_ Potential for binding - are load cells required to verify the load is free?
_ Attachment points designed to take the load weight
_ Is the load structurally capable of being lifted? *(bending/twisting issues)*

RIGGING

_ Determine the additional tensions based on the sling angles
_ Ensure all rigging has adequate capacity for the additional tension
_ Are shackles correctly sized for the sling eyes? D/d requirements met?

PERSONNEL

_ The roles, responsibilities and qualifications for personnel have been defined *(P.I.C., Riggers, Signalperson, Crane Operator, etc.)*
_ A pre-lift meeting has been held with all personnel

AREA PREPARATION

_ The location for landing the load has been selected and prepared
_ Blocking or cribbing is available to set the load on
_ A travel path has been determined and cordoned off
_ Other personnel in the area have been notified of the lift

CRANE CONSIDERATIONS (Mobile Cranes)

_ Is the lift within the crane's rated capacity (boom height/radius)?
_ Have boom deflections been considered?
_ Have any potential crane boom obstructions been identified?
_ What are the limits on wind speed for making this lift?
_ Have the ground bearing support conditions been met?
_ Power lines in the area? Clearance and a spotter established?
_ Counterweight swing area of the crane barricaded?

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Lifting Operations

HOISTING GUIDE

This is a general guide only and NOT a comprehensive list of all requirements

PRIOR TO THE LIFT

_ The rigging has been inspected before use
_ The crane hook is positioned directly over the load's center of gravity
_ Softeners are used to protect the rigging where it could be damaged
_ The slings and rigging hardware positioned correctly?
_ Rigging provides positive control of the load? (no slipping/shifting)
_ Safe load paths have been established
_ Tag lines are being used to control the load (where appropriate)
_ Communications between signalperson and crane operator have been established

DURING THE LIFT

1) Tension is gradually applied to the slings and rigging is re-checked
2) **Lift and hold** the load to verify the center of gravity and load stability
3) Personnel are not under the load or travel path (includes hands/feet)
4) Personnel avoid being in the 'line of fire' of tensioned rigging
5) Lifted load is kept as close to the ground as possible
6) Loads lifted high require extra distance for personnel (potential for the load to swing or bounce if rigging fails and the load falls)

AFTER THE LIFT

_ A post-lift inspection performed on the load and rigging *(in the locations subjected to forces applied from the lifting and/or near softeners or where slings came in physical contact with the load)*
_ A post-lift meeting is held (if applicable)
_ Rigging equipment stored appropriately in proper location(s)

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STANDARDS

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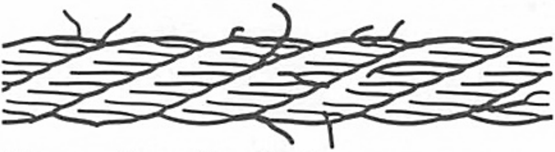

Wire rope inspection chart

The inspection criteria for wire rope depends entirely on the intended use, and the applicable regulatory code that the inspection is based on. The following table lists some of the more common standards that address inspection criteria.

Rope Replacement based on the number of Broken WIres		Number of Broken wires			
		Running Ropes		Standing Ropes	
		In one:	In one:	In one:	At end connection
Standard	Equipment	lay	strand	lay	
ASME B30.2	Overhead & Gantry Cranes	12	4	(not specified)	
ASME B30.3	Hammerhead Tower Cranes	6	4	3	2
ASME B30.4	Portal, Tower, PillarCranes	6	3	3	2
ASME B30.5	Crawler, locomotive, Truck cranes	6	3	3	2
ASME B30.6	Derricks	6	3	3	2
ASME B30.7	Base Mounted Drum Hoists	6	3	3	2
ASME B30.8	Floating Cranes and Derricks	6	3	3	2
ASME B30.9	SLINGS	10	5	(not specified)	

References

The following list of regulations and standards is not exhaustive, but is intended to give a general idea of the key points addressed with them.

The ANSI/ASME standards are the foundation for most rigging requirements and standards.

Listed below are the volumes related to cranes and rigging:

B30.1 Jacks
B30.2 Overhead and Gantry Cranes
B30.3 Construction Tower Cranes
B30.4 Portal, Tower, and Pedestal Cranes
B30.5 Mobile and Locomotive Cranes
B30.6 Derricks
B30.7 Base Mounted Drum Hoists
B30.8 Floating Cranes and Floating Derricks
B30.9 Slings
B30.10 Hooks
B30.11 Monorails and Underhung Cranes
B30.12 Handling Loads Suspended From Rotorcraft
B30.13 Storage/Retrieval Machines
B30.14 Side Boom Tractors
B30.15 Mobile Hydraulic Cranes (withdrawn see B30.5)
B30.16 Overhead Hoists (Underhung)
B30.17 Overhead and Gantry Cranes
B30.18 Stacker Cranes
B30.19 Cableways
B30.20 Below-the-Hook Lifting Devices
B30.21 Manually Lever Operated Hoists
B30.22 Articulating Boom Cranes
B30.23 Personnel Lifting Systems
B30.24 Container Cranes
B30.25 Scrap and Material Handlers
B30.26 Rigging Hardware
B30.27 Material Placement Systems
B30.28 Balance-Lifting Units

The following is a listing of various Industry Standards and where to obtain them:

Global Engineering Documents
15 Inverness Way East
Englewood CO 80112
303-397-7956
www.global.ihs.com
They carry most worldwide standards, including ANSI/ASME

OSHA
Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210
www.osha.gov

ASME International
Three Park Avenue
New York, NY 10016-5990
800-843-2763
www.asme.org

American Petroleum Institute
1220 L Street NW
Washington, DC 20005
Phone 202-682-8000
www.api.org

INDUSTRY ASSOCIATION REFERENCES

WIRE ROPE TECHNICAL BOARD
P.O. BOX 14921
SHAWNEE MISSION, KS 66285
"WIRE ROPE USER'S MANUAL" and "WIRE ROPE SLING USERS MANUAL"

WEB SLING AND TIE DOWN ASSOCIATION
710 E. OGDEN AVENUE. SUITE 600
NAPERVILLE. IL 60563

Inspection Intervals

A specific procedure for the inspection of synthetic slings is the best safeguard against sling damage and abuse. Slings removed from service that are not capable of repair should be destroyed and rendered completely unfit for any future use.

INITIAL

"prior to use, all new, altered, modified or repaired slings shall be inspected by a designated person to verify compliance to all applicable standards". *The initial level of inspection is done upon receipt to ensure that no damage has occurred during transit. The products must also be verified to be correct, as ordered, and that they comply with the manufacturer's specifications.*

FREQUENT

The frequent level of inspection should be done by the person handling the sling, before every use. The entire sling should be thoroughly examined and removed from service if damage is detected. OSHA stipulates that, "each day before being used, the sling and all fastenings and attachments shall be inspected for damage and defects by a competent person designated by the employer."

Any condition that may result in a hazard shall cause the sling to be removed from service. Written inspection records are not required for frequent inspections.

PERIODIC

The periodic level of inspection should be done by designated personnel at regular intervals. The interval is based upon the frequency of use, severity of the service conditions and information derived through the inspection process. Periodic inspection intervals shall not exceed one year intervals.

ASME guidelines for the inspection time intervals are as follows:

Normal Service - Yearly
Severe Service - Monthly or Quarterly
Special Service - As recommended by a qualified person

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Sling Identification

REMOVAL CRITERIA

OSHA 1926.251(a)(2)(iii)

"Slings SHALL NOT be used without affixed, legible identification markings"

ASME B30.9-2010

"A sling shall be removed from service if missing sling identification or its illegible"

Sling identification can only be done by the sling manufacturer and should be legible during the life of the sling - replacement of the sling tag is considered a repair.

Marking Requirements for Slings

(ASME B30.9-2010)

					Rated Load				
	manufacturer name (a)	type of material (b)	size, dia, width, gauge (c)	number of legs (d)	vertical / bridal hitch (e)	type hitch / angle (f)	length, reach (g)	serial # (h)	code # (i)
Alloy steel chain slings [(1)]	✓	✓	✓	✓	✓		✓	✓	
Wire rope slings	✓		✓	✓		✓*			
Metal mesh slings	✓		✓	✓		✓		✓	
Web slings	✓	✓	✓	✓		✓			✓
Roundslings	✓	✓	✓	✓		✓			✓
Rope slings	✓	✓		✓		✓			✓

(a) name or trademark of sling manufacturer

(b) type of material used (synthetic, steel, etc)

(c) diameter, width/gauge, or nominal chain size (depending on sling type)

(d) number of legs, if more than one

(e) rated loads for the vertical hitch and bridal hitch, and the angle its based on

(f) rated loads for each type(s) of hitch(es) used, and the angle its based on

(g) reach or length of the sling

(h) individual sling identification (e.g., serial numbers)

(i) manufacturer code or stock number

Exceptions:

Wire Rope

* ***OSHA 1926.251(c)(16)*** requires marking for ALL the type(s) of hitch(es) used and the angle upon which they are based.

ASME B30.9 only requires ONE hitch type and the angle upon which it is based

Chain

(1) ***1926.251(b)(1)*** ONLY requires the size, grade, rated capacity, and the sling manufacturer name

References used:

ASME B30.9 - 2010 edition

OSHA 1926.251 - as of June 2012

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Temperature limits

Temperature Limits for Slings

ASME B30.9-2010

(ASME B30.9-2010)	*Fahrenheit*		*Celsius*	
	MIN	MAX	MIN	MAX
Alloy steel chain slings (1)	−40°F	400°F	−40°C	205°C
Fiber core wire rope slings	–	*180°F*	–	*82°C*
IWRC wire rope slings	−40°F	400°F	−40°C	205°C
Metal mesh slings	*−20°F*	550°F	*−29°C*	288°C
Metal mesh slings (elastometer coated)	*0°F*	*200°F*	*−18°C*	*93°C*
Web slings (Nylon & Polyester)	−40°F	194°F	−40°C	90°C
Roundslings (Polyester)	−40°F	194°F	−40°C	90°C
Rope slings (Nylon & Polyester)	−40°F	194°F	−40°C	90°C

The sling manufacturer should be consulted when the slings are to be used in temperatures outside of those shown.

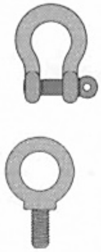
(1) Alloy steel chain slings may be used at temperatures up to 1000°F (538°C), but ONLY at reduced capacities as recommended by the sling manufacturer, but they must be removed from service if exposed to temperatures greater than 1000°F

NOTE: Some synthetic yarns (Kevlar/Aramid) do not retain their published breaking strength above 140°F (60°C) consult manufacturer.

OSHA 1910.184 lists: Polyester and nylon web slings: maximum 180° F., Polypropylene web slings maximum 200° F. - Fiber core wire rope slings permanently removed from service if exposed in excess of 200° F. IWRC above 400° F or below minus 60° F

Temperature Limits for Hardware

ASME B30.26-2010



	Fahrenheit	
ASME B30.26	**Min**	**Max**
Shackles	-40°	400°
Eyebolts & Eyenuts (alloy)	-40°	400°
Turnbuckles, Wire rope clips	-40°	400°
Links, rings, swivels (steel)	-40°	400°
Swivel Hoist Rings	-20°	400°
Wedge Sockets	-4°	400°
Rigging Blocks, Snatch blocks	0°	150°
Eyebolts (carbon steel)	30°	275°

"when equipment is to be used at temperatures above or below those shown, the manufacturer or a qualified person should be consulted"

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Inspection: Wire Rope Slings

Reference:
ASME B30.9 - 2010 and OSHA 1910.184

REMOVAL CRITERIA

..shall be removed from service if any of the following conditions are found:

» missing or illegible sling identification

» **broken wires**

strand-laid and single-part slings
10 randomly distributed broken wires in one wire rope lay, or 5 broken wires in one strand in one wire rope lay
cable-laid slings, 20 broken wires per lay
- for less than eight-part braided slings, 20 broken wires per braid
- eight-part braided slings, 40 broken wires per braid

» severe localized abrasion or scraping

» scraping of 1/3 the original diameter of outside individual wires

» kinking, crushing, birdcaging

» any other damage resulting in damage to the rope structure

» evidence of heat damage

» end attachments that are cracked, deformed, or worn

» severe corrosion of the rope, end attachments, or fittings

» any other conditions that cause doubt to the continued use

Minimum sling lengths (ASME B30.9 - 2010 and OSHA 1910.184):

» Cable laid and 6x19 and 6x37 slings shall have a minimum clear length of wire rope 10 times the component rope diameter between splices, sleeves or end fittings

» Braided slings shall have a minimum clear length of wire rope 40 times the component rope diameter between the loops or end fittings

» Cable laid grommets, strand laid grommets and endless slings shall have a minimum circumferential length of 96 times their body diameter

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SLINGS
HARDWARE
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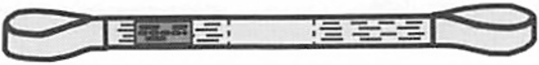
Inspection: Synthetic Webbing Slings



REMOVAL CRITERIA

Reference: ASME B30.9

..shall be removed from service if any of the following conditions are found:

» missing or illegible sling identification

» acid or caustic burns

» melting or charring of any part of the sling

» holes, tears, cuts, or snags

» broken or worn stitching in load bearing splices

» excessive abrasive wear

» knots in any part of the sling

» chemical or ultraviolet damage (discoloration and brittle)

» fittings that are pitted, corroded, cracked, bent, twisted, gouged, or broken

» any other conditions that cause doubt to the continued use

About "Red Threads"

Some slings MAY have a red thread woven into the sling to serve as a warning and when exposed you must remove the sling from service.

However, red threads are not the only criteria for determining the removal of web slings from service.

Not all slings contain a red thread!

Note: The "red thread" is not mentioned in any OSHA regulation or ASME standard.

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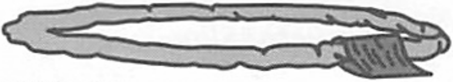
Inspection: Synthetic Roundslings



REMOVAL CRITERIA

Reference: ASME B30.9

..shall be removed from service if any of the following conditions are found:

» missing or illegible sling identification

» acid or caustic burns

» evidence of heat damage

» holes, tears, cuts, or snags ***that expose the core yarns***

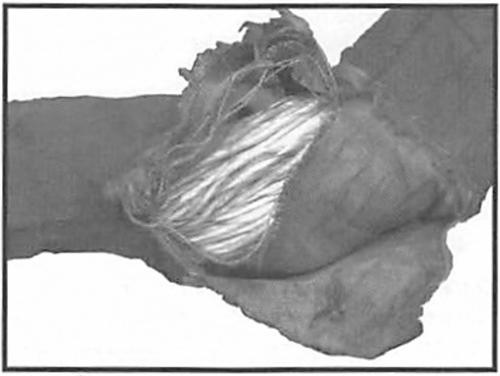
» broken or damaged core yarns

» weld splatter ***that exposes core yarns***

» knots in the roundsling, except for core yarns inside the cover

» fittings that are pitted, corroded, cracked, bent, twisted, gouged, or broken

» any other conditions that cause doubt to the continued use



exposed core yarns . . .

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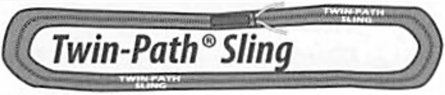
Inspection: *Twin-Path® Slings*



REMOVAL CRITERIA

..shall be removed from service if any of the following conditions are found:

- missing or illegible sling identification
- acid or caustic burns
- evidence of heat damage
- holes, tears, cuts, or snags ***that expose the core yarns***
- broken or damaged core yarns
- weld splatter ***that exposes core yarns***
- knots in the roundsling, except for core yarns inside the cover
- fittings that are pitted, corroded, cracked, bent, twisted, gouged, or broken
- any other conditions that cause doubt to the continued use

Reference: ASME B30.9

The unique inspection items shown below are ONLY available on products fabricated and sold by authorized SLINGMAX® Dealers.

Tell-Tails:

The Tell-Tails are overload indicators and will retract and eventually disappear if the sling is overloaded.

Tell-Tails should extend past the tag area of the sling. If either Tell-Tail is not visible, remove the sling from service, send the sling to the manufacturer for repair evaluation.

Fiber Optic Inspection system: ***<- NOT an overload indicator!***

The Fiber Optic determines if the interior core of the sling has suffered chemical, heat or crushing damage. If light does not pass from one end to the other, remove the sling from service and send to the manufacturer for repair evaluation.

The Check-Fast® Tag and External Warning Indicator (EWI):

This system provides for a quick pass/fail inspection of the internal load bearing core yarn. If the sling is overloaded beyond rated capacity, the EWI is designed to disappear before the sling fails.

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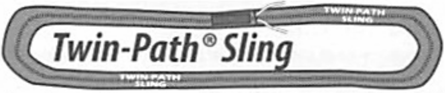
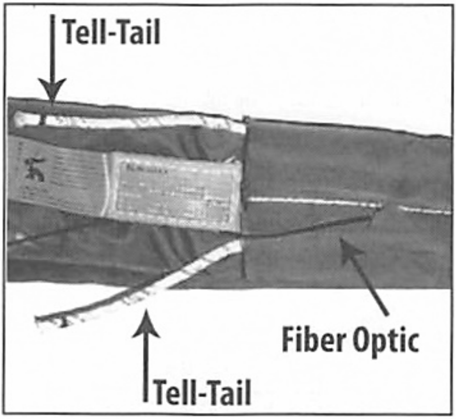
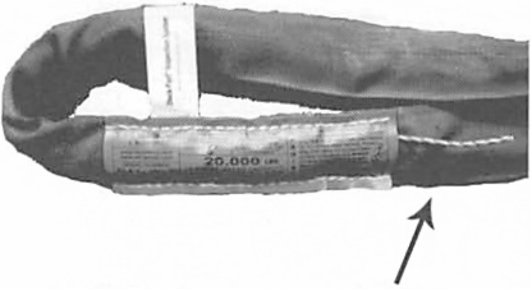
Inspection: *Twin-Path® Slings*


Twin-Path® Sling
TWIN-PATH SLING
TWIN-PATH SLING

The unique inspection items shown below are ONLY available on products fabricated and sold by authorized SLINGMAX® Dealers.


Tell-Tail
Fiber Optic
Tell-Tail



Check-Fast® External Warning Indicator (EWI)

Graphics ©2012 Jerry Klinke

Inspection: Chain Slings

REMOVAL CRITERIA

..shall be removed from service if any of the following conditions are found:

- missing or illegible sling identification
- cracks or breaks, excessive wear, nicks, or gouges
- stretched chain links or components
- bent, twisted, or deformed chain links or components
- evidence of heat damage, weld splatter
- excessive pitting or corrosion
- lack of ability of chain or components to articulate freely
- any other conditions that cause doubt to the continued use

- Cracked, broken, or bent chain links or components shall be replaced not repaired.
- Mechanical coupling links can not be used within the body of an alloy chain sling to connect two pieces of chain.
- Any modifications to the sling or components are considered repairs, proof test requirements may apply, refer to ASME B30.9 for specifics

Minimum allowable thickness at any point on a link			
Chain Link Size		Minimum Thickness Allowed	
in	mm	in	mm
7/32"	5.5	0.189	4.8
9/32"	7	0.239	6.07
5/16"	8	0.273	6.93
3/8"	10	0.342	8.69
1/2"	13	0.443	11.26
5/8"	16	0.546	13.87
3/4"	20	0.687	17.45
7/8"	22	0.75	19.05
1"	26	0.887	22.53
1-1/4"	32	1.091	27.71

Reference: ASME B30.9, table 1.9.4-1

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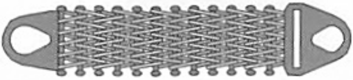
Inspection: Mesh Slings



REMOVAL CRITERIA

Reference: ASME B30.9

..shall be removed from service if any of the following conditions are found:

» missing or illegible sling identification

» broken weld or a broken brazed joint along the sling edge
broken wire in any part of the mesh

» reduction in wire diameter of 25% due to abrasion or 15% due to corrosion

» lack of flexibility due to distortion of the mesh
distortion of the choker fitting so the depth of the slot is increased by more than 10%

» distortion of either end fitting so the width of the eye opening is decreased by more than 10%

» a 15% reduction of the original cross-sectional area of any point around the hook opening of the end fitting

» visible distortion of either end fitting out of its plane

» cracked end fittings

» slings in which the spirals are locked or without free articulation shall not be used

» fittings that are pitted, corroded, cracked, bent, twisted, gouged, or broken

» any other conditions that cause doubt to the continued use

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Inspection: Hardware

REMOVAL CRITERIA

..shall be removed from service if any of the following conditions are found:

These conditions apply to ALL hardware...

» missing or illegible manufacturer's name or trademark

» indications of heat damage, including weld spatter or arc strikes

» excessive pitting or corrosion

» bent, twisted, distorted, stretched, elongated, cracked, or broken load-bearing components

» excessive nicks or gouges

» evidence of unauthorized welding

» any other conditions that cause doubt to the continued use

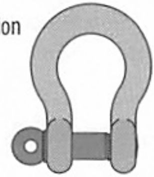
Additional criteria unique to SHACKLES:

» missing or illegible **rated load identification**

» a 10% reduction of the original dimension anywhere around the body or pin

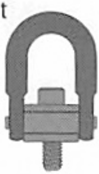
» incomplete pin engagement

» excessive thread damage



Additional criteria unique to SWIVEL HOIST RINGS:

» the lack of the ability to freely rotate or pivot



Reference:
ASME B30.26 - 2010 edition

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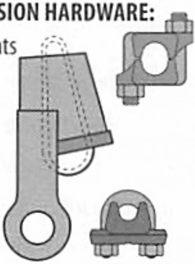
Inspection: Hardware

Additional criteria unique to COMPRESSION HARDWARE:

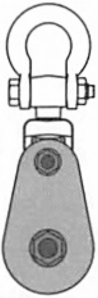


- » unauthorized replacement components
- » insufficient number of wire rope clips
- » improperly tightened wire rope clips
- » indications of damaged wire rope
- » indications of wire rope slippage
- » improper assembly

Additional criteria unique to SWIVELS:

- » loose or missing nuts, bolts, cotter pins, snap rings, or other fasteners and retaining devices

Additional criteria unique to RIGGING BLOCKS:



- » misalignment or wobble in sheaves
- » excessive sheave groove corrugation or wear
- » loose or missing nuts, bolts, cotter pins, snap rings, or other fasteners and retaining devices
- » indications of heat damage, including weld spatter or arc strikes
- » excessive damage to load-bearing threads

Reference:
ASME B30.26 - 2010 edition

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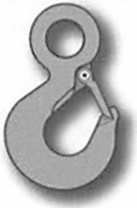
Inspection: Hooks

Hooks shall be removed from service if any of the following conditions are found:



- » missing or illegible manufacturer's ID
- » missing or illegible rated load marking
- » excessive pitting or corrosion
- » cracks, nicks, or gouges
- » wear - any wear exceeding 10% of the original section dimension of the hook or its load pin **
- » deformation - **ANY visibly apparent bend or twist** from the plane of the unbent hook
- » throat opening - any distortion causing an increase in throat opening of **5%** not to exceed 1⁄4 in. (6 mm)**
- » inability to lock - any self-locking hook that does not lock
- » inoperative hook latch (if required)
- » thread wear, damage, or corrosion
- » evidence of excessive heat exposure or unauthorized welding
- » evidence of unauthorized alterations such as drilling, machining, grinding, or other modifications

***** or as recommended by the manufacturer***

Reference:
ASME B30.10 - 2009 edition

It's recommended that you follow the ASME standards shown above. However, OSHA has an older removal criteria that's in conflict with the current ASME provisions...

OSHA 1910.184(e)(9)(ii) states: "Slings shall be removed from service if hooks are cracked, have been opened more than 15 percent of the normal throat opening measured at the narrowest point or twisted more than 10 degrees from the plane of the unbent hook"

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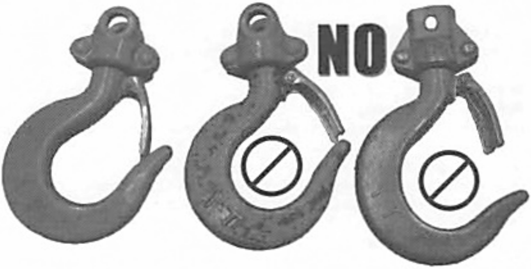
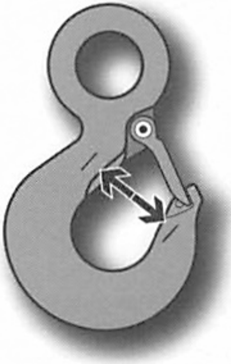
Inspection: Hooks

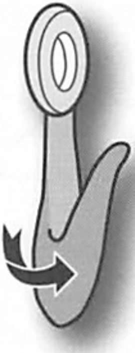
If the hook latch does not touch the hook, remove it from service! This is an obvious sign of an overloaded hook....





Spread

"any distortion causing an increase in throat opening of **5%** not to exceed ¼ in"



Twist

"**ANY** visibly apparent bend or twist from the plane of the unbent hook"

Ref: ASME B30.10 - 2009

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API RP 2D Overview

A QUALIFIED OPERATOR is a person so designated by the employer. Who has appropriate offshore experience and training, documented training in both classroom and "hands on" is required. There are two levels of proficiency, non-mechanical and mechanical. The qualified operator should be qualified to perform pre-use and monthly inspection. A qualified operator is also considered a qualified rigger.

THE QUALIFIED OPERATOR WILL:

- Be responsible for the operations under direct control
- Stop and refuse to handle loads as safety dictates
- Be a ware of crane's operating characteristics
- Be familiar with the equipment and its care
- Never start machine movement unless load or signal person is within range of vision
- Respond to signals only from appointed signal person
- Obey an emergency stop signal given by any person at any time
- Verify that appropriate load charts are in place for the crane configuration in use
- Secure the crane against swinging when not in use
- Will not operate crane in proximity of helidecks while helicopter is landing or taking off
- Insure there is sufficient lighting when cranes used at night
- Will not allow field welding on load hooks or sling hooks
- The operator will maintain log of pre use inspection.

Qualified Rigger

A qualified rigger is a person with training and experience that has successfully completed a rigger training program.

A rigger is anyone who attaches or detaches lifting equipment to loads or lifting devices.

Qualified Inspector

A qualified inspector is a person so designated by the employer who has appropriate experience and training. In addition to meeting the requirements of a qualified operator, has attended formal training on crane maintenance and troubleshooting. Documented training, both classroom and "hands on" is required.

This information is provided as an overview of the subject matter covered. The user of this book must understand that the publisher is not engaged in rendering legal, engineering, or other professional services. If legal or other expert assistance is required, contact certified professional for advice.

Offshore Rigging

API RP 2D requires before starting to lift, verify:

- If there is a slack rope condition, the rope is properly seated on the drum and in the sheaves.
- The correct slings have been selected for the weight to be lifted.
- The load is free to be lifted.
- Multiple part lines are not twisted around each other in such a manner that all of the lines will not separate upon application of load.
- The hook is brought over the load in such a manner to minimize swinging.

API RP 2D requires that during lifting, care should be taken that:

- Acceleration or deceleration of the moving load is accomplished in a smooth manner.
- That load, boom, or other parts of the machine do not contact any obstruction. The operator should engage the controls smoothly to avoid excessive stress on the crane.
- When rotating the crane, sudden starts and stops should be avoided.
- Rotational speed shall be such that the load does not swing out beyond the radius at which it can be controlled.

API RP 2D requires that during personnel transfer:

- All hooks used for support of personnel will have a safety latch. (latch with redundant locking)
- When making personnel lifts, the load will be under control in both up and down directions.
- All personnel to be lifted will use approved personnel flotation devices.
- Personnel riding on net type carriers should stand on outer rim facing inward.

Offshore Slings

API RP 2D requires that:

- Wire rope slings should not be field fabricated.
- If circumstances require field fabrication qualified inspectors should perform this function using accepted practices.
- Zinc or resin poured sockets shall be fabricated in accordance with API recommended practices
- Slings of all types will be proof loaded by the sling manufacturer per industry recommendations.
- All slings will be labeled with manufacturer and pertinent working load limits, proof test certification number, length, diameter, and date of proof test.
- Rated loads of a sling are different for each of the three basic methods of rigging (vertical, choker, basket).
- Rated loads of a sling is different for each of the methods of rigging based on construction of the rope, web material and width, etc.
- The rated loads will be indicated on the heavy duty tags attached to each type of sling at the time it is fabricated.
- Slings of other than wire rope construction will be used, inspected, and tested in accordance with the. Sling manufacturer and industry recommendations

This information is provided as an overview of the subject matter covered. The user of this book must understand that the publisher is not engaged in rendering legal, engineering, or other professional services. If legal or other expert assistance is required, contact certified professional for advice.

OSHA's Rule on Steel Erection (effective Date: 1/18/02)

This rule is intended to protect employees from the hazards associated with steel erection. Any employees involved in the construction, alteration and/or repair of single and multi-story buildings, bridges and other structures where steel erection occurs fall under this rule.

Steel erection activities include hoisting, connecting, welding, bolting and rigging structural steel, steel joists and metal buildings; installing metal deck, siding systems, miscellaneous metals, ornamental iron and similar materials; and moving point-to-point while performing these activities.

§1926.753 Hoisting and Rigging requires:

- A Pre-shift inspection of cranes by a competent person
- A certification that this inspection was performed
- The operator is responsible for those operations under the operator's direct control
- A qualified rigger shall inspect the rigging prior to each shift
- Cranes may hoist employees with a personnel platform meeting the requirements of 1926.550
- Working under loads, routes must be preplanned to assure no employee required to work under a suspended load except:
    - Connectors
    - Employees responsible for hooking/unhooking the load

When working under suspended loads:
Routes shall be pre-planned
- Materials shall be rigged to prevent unintentional displacement
- Hooks shall have self-closing latches

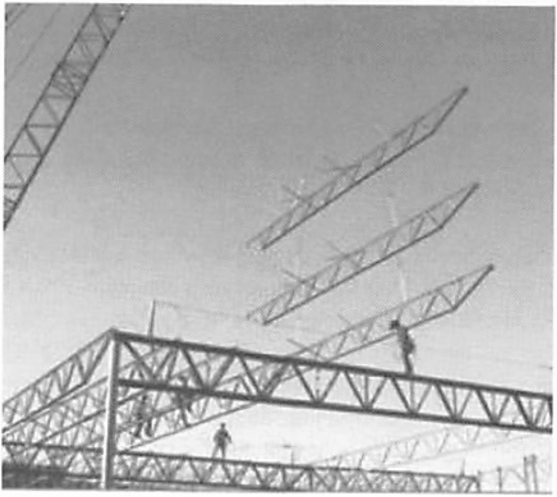
- Multiple lift Rigging procedure can be used only if:
  - Maximum of 5 members
  - Only structural members
  - All employees have been trained
- Components shall be designed with a 5 to 1 safety factor
- Total load shall not exceed the rated capacity of the hoisting equipment or the rigging equipment
- Rigging assembly shall be rigged with the members attached at their center of gravity and maintained reasonably level; rigged from the top down; rigged at least 7 ft. apart.

Multiple Lift Rigging

Multiple Lift Rigging Procedure "Christmas Treeing"

Multiple Lift Rigging procedure can be used only with:
1) Maximum of 5 members
2) Only structural members
3) Properly trained employees

Rigging assembly shall be rigged with:
1) the members attached at their center of gravity
2) maintained reasonably level
3) rigged from the top down
4) rigged at least 7 ft apart



Safety Standards for Steel Erection; Federal Register: 29 CFR 1926.750-761, Subpart M, 1926.502 and §1926.105

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Regulation Overview

Subpart CC – Cranes and Derricks in Construction: Qualified Rigger (29 CFR 1926.1401, 1926.1404, and 1926.1425 - effective November 8, 2010)

When is a qualified rigger required?

Employers must use qualified riggers during hoisting activities for assembly and disassembly work (1926.1404(r)(1)). Additionally, qualified riggers are required whenever workers are within the fall zone and hooking, unhooking, or guiding a load, or doing the initial connection of a load to a component or structure (1926.1425(c)).

Who can be a qualified rigger?

A qualified rigger is a rigger who meets the criteria for a qualified person. Employers must determine whether a person is qualified to perform specific rigging tasks. Each qualified rigger may have different credentials or experience.

A qualified rigger is a person that:

- possesses a recognized degree, certificate, or professional standing

or

- has extensive knowledge, training, and experience, and can successfully demonstrate the ability to solve problems related to rigging loads.

The person designated as the qualified rigger must have the ability to properly rig the load for a particular job. It does not mean that a rigger must be qualified to do every type of rigging job.

Each load that requires rigging has unique properties that can range from the simple to the complex. For example, a rigger may have extensive experience in rigging structural components and other equipment to support specific construction activities.

However, this experience does not automatically qualify the rigger to rig unstable, unusually heavy, or eccentric loads that may require a tandem lift, multiple-lifts, or use of custom rigging equipment.

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Regulation Overview

Subpart CC – Cranes and Derricks in Construction: Qualified Rigger (29 CFR 1926.1401, 1926.1404, and 1926.1425 - effective November 8, 2010)

Do qualified riggers have to be trained or certified by an accredited organization or assessed by a third party?

No - Riggers do not have to be certified by an accredited organization or assessed by a third party. Employers may choose to use a third party entity to assess the qualifications of the rigger candidate, but they are not required to do so.

Does a certified Crane operator also meet the requirements of a qualified rigger?

A certified operator does not necessarily meet the requirements of a qualified rigger. Determining whether a person is a qualified rigger is based on the nature of the load, lift, and equipment used to hoist that load plus that person's knowledge and experience. A certified/qualified operator may meet the requirements of a qualified rigger, depending on the operator's knowledge and experience with rigging.

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Subpart CC – Cranes and Derricks in Construction: Assembly/Disassembly (as specified in 29 CFR 1926.1403-1926.1406 and 192.1412)

Procedures

Under this standard, employers must comply with all manufacturer prohibitions regarding assembly and disassembly. However, the standard generally allows employers to choose between the manufacturer's procedures or their own (see exception below for synthetic slings procedures). Employer procedures must be developed by a "qualified person" and must satisfy a number of specified requirements, such as providing adequate support and stability for all parts of the equipment, and positioning employees involved to minimize exposure to any unintended movement or collapse.

Assembly/Disassembly responsibilities

- The rule requires the work to be directed by an A/D (Assembly/Disassembly) director. The A/D director must meet the criteria for both a "competent person" and a "qualified person," which are defined terms in this rule, or must be a "competent person" assisted by a "qualified person."
- The A/D director must understand the applicable procedures.
- The A/D director must review the procedures immediately prior to beginning work unless he or she understands the procedures and has used them before for that equipment type and configuration.
- The A/D director must ensure that each member of the crew understands his or her tasks, the hazards of the tasks, and any hazardous positions or locations to avoid.
- The A/D director must verify all capacities of any equipment used, including rigging, lifting lugs, etc.
- The A/D director must also address hazards associated with the operation, including 12 specified areas of concern: site and ground conditions, blocking material, proper location of blocking, verifying assist crane loads, boom & jib pick points, center of gravity, stability upon pin removal, snagging, struck by counterweights, boom hoist brake failure, loss of backward stability, and wind speed and weather.

Inspection

- Upon completion of assembly, but before use, the equipment must be inspected by a "qualified person" to ensure that it is configured in accordance with the manufacturer equipment criteria. If these criteria are unavailable, the employer's "qualified person," with the assistance of a registered professional engineer if necessary, must develop the appropriate configuration criteria and ensure that these criteria are met.

General requirements

- A crew member who moves out of the operator's view to a location where the crew member could be injured by movement of the equipment (or load) MUST inform the operator before going to that location. The operator must not move the equipment until that crew member informs the operator that he or she has relocated to a safe position.
- Employees must never be under the boom or jib when pins (or similar devices) are being removed, unless it is required by site constraints and the A/D director has implemented procedures that minimize the risk of unintended movement and the duration and extent of exposure under the boom.
- Component weights must be readily available for all components to be assembled.
- All rigging must be done by a "qualified rigger."
- Pins may not be removed during disassembly when the pendants are in tension.
- Booms supported only by cantilevering must not exceed manufacturer limitations or RPE limitations, as applicable.
- Component selection and equipment configuration that affects the capacity or safe operation of the equipment must be in accordance with manufacturer requirements and limits or RPE requirements and limits, as applicable

Synthetic slings

- The employer must follow manufacturer procedures when using synthetic slings during assembly or disassembly rigging (even when the employer has developed its own A/D procedure as an alternative to the manufacturer's other procedures.)

- Synthetic slings must be protected from abrasive, sharp or acute edges, and configurations that might reduce the sling's rated capacity.

Outriggers and stabilizers

When outriggers or stabilizers are used or are necessary in light of the load to be handled and the operating radius:

- Outriggers and stabilizers must be fully extended or, if permitted by manufacturer procedures, deployed as specified in the load chart.
- Outriggers must be set to remove equipment weight from the wheels, except for locomotive cranes.
- Outrigger floats, if used, must be attached to the outriggers; stabilizer floats, if used, must be attached to the stabilizers.
- Each outrigger or stabilizer must be visible to the operator or to a signal person during extension and setting.
- Outrigger and stabilizer blocking must be placed under the float/pad of the jack or, if there is no jack, under the outer bearing surface of the outrigger or stabilizer beam. Blocking must also be sufficient to sustain the loads and maintain stability and must be properly placed.

Tower cranes

- Tower cranes are subject to additional requirements for erecting, climbing and dismantling, including a pre-erection inspection (29 CFR 1926.1435).

This overview is intended to address the most common questions. It does not, however, describe all provisions of the standard which is published at 29 CFR 1926.1400 - 1442. The reader must refer to the standard itself, which is available on OSHA's website and in the Federal Register and will be published in the Code of Federal Regulations, to determine all of the steps that must be taken to comply with the standard.

DISMANTLING BOOMS AND JIBS

The following precautions must be taken to prevent dangerous movement of boom and jib sections that are being dismantled.

- None of the pins in the pendants are to be removed (partly or completely) when the pendants are in tension.
- None of the pins (top or bottom) on boom sections located between the pendant attachment points and the crane/derrick body are to be removed (partly or completely) when the pendants are in tension.
- None of the pins (top or bottom) on boom sections located between the uppermost boom section and the crane/derrick body are to be removed (partly or completely) when the boom is being supported by the uppermost boom section resting on the ground (or other support).
- None of the top pins on boom sections located on the cantilevered portion of the boom being removed (the portion being removed ahead of the pendant attachment points) are to be removed (partly or completely) until the cantilevered section to be removed is fully supported.

FALL PROTECTION

During assembly/disassembly work, fall protection is generally required when a worker is more than 15 feet above an unprotected side or edge.

OSHA 1926.1428 - SIGNAL PERSON QUALIFICATIONS

Each signal person must meet the following qualification requirements:

1. **Know and understand the type of signals used. If hand signals are used, the signal person must know and understand the Standard Method for hand signals.**
2. **Be competent in the application of the type of signals used.**
3. **Have a basic understanding of equipment operation and limitations, including the crane dynamics involved in swinging and stopping loads and boom deflection from hoisting loads.**
4. **Know and understand the relevant requirements of the sections of the standard dealing with signals.**
5. **Demonstrate that he/she meets these requirements through an oral or written test, and through a practical test.**

The employer of the signal person must ensure that the signal person meets these Qualification Requirements through one of the following qualification options:

Option (1) – Third party qualified evaluator. The signal person has documentation from a third party qualified evaluator (see section 1401 for definition of "Qualified Evaluator (third party)") showing that the signal person meets the qualification requirements.

Option (2) – Employer's qualified evaluator. The employer's qualified evaluator (see section 1401 for definition of "Qualified Evaluator (not a third party)") and determines that the individual meets the qualification requirements.

The employer must make the documentation for whichever option is used available at the site while the signal person is employed by the employer. Such documentation is considered "available" when it is physically present on the site or retrievable via an on-site computer. ***The documentation must specify each type of signaling (e.g., hand signals, radio signals, etc.) for which the signal person is qualified.***

If subsequent actions by the signal person indicate that the individual does not meet the qualification requirements, the employer must not allow the individual to continue working as a signal person until retraining is provided and a reassessment is made under one of the two options that confirms that the individual meets the qualification requirements.

SIGNALS (OSHA 1926-1419-1422)

A crane operator often needs a second set of eyes, in the form of a signal person, to be able to operate safely. These sections state when a signal person must be provided and the types of signals that are allowed. The qualifications the signal person must possess are specified in (OSHA 1926.1428).

When a Signal person is required - In each of the following situations, a signal person must be provided:

1. **When the point of operation, meaning the path the load travels or the area where the load is placed, is not in full view of the operator.**
2. **When the equipment is traveling and the operator's view in the direction of travel is obstructed.**
3. **When, due to site-specific safety concerns, either the operator or the person handling the load determines that it is necessary.**

During operations requiring signals, the ability to transmit signals between the operator and signal person must be maintained. If that ability is interrupted at any time, the operator must safely stop operations until signal transmission is reestablished and a proper signal is given and understood.

Only one person may give signals to a crane at a time, except that ANY person may give an emergency stop signal.

TYPES OF SIGNALS:

Hand, voice, audible, or new signals are allowed. The type of signals used to transmitt the signals to the operator (such as direct line of sight, video, radio, etc.), must be appropriate for the site conditions.

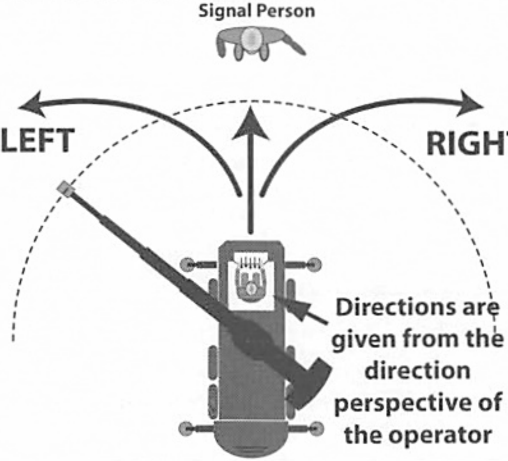
Hand Signals

When using hand signals, the Standard Method must be used.

Exception: Where an operation or use of an attachment is not covered in the Standard Method or the use of the Standard Method is otherwise infeasible, non-standard hand signals may be used. When using non-standard hand signals, the signal person, operator, and lift director (where there is one) must contact each other prior to the operation and agree on the non-standard hand signals that will be used. Hand signal charts must be either posted on the equipment or conspicuously posted in the vicinity of the hoisting operation.

Crane Dynamics & Operations

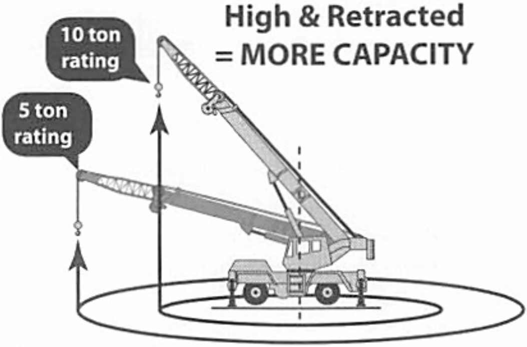
Direction Perspective


Signal Person
LEFT
RIGHT

Directions are given from the direction perspective of the operator

Simplified Load Radius

High & Retracted
= MORE CAPACITY


10 ton rating
5 ton rating

Low & Extended
= LESS CAPACITY

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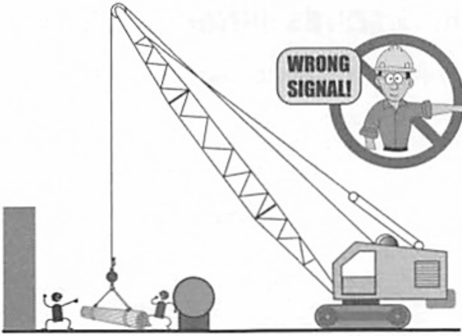
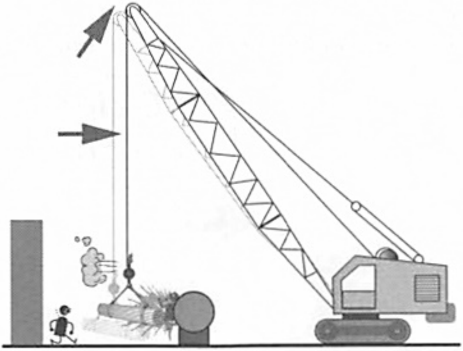
Crane Dynamics & Operations



The signal person intends to signal to the crane operator to ***hoist up***, since the load needs to be raised straight up.

Think about the load movement
Think about what signal to use
THEN signal the crane operator!



However, the signal person uses the signal for ***booming up*** in the mistaken belief that this signal is for hoisting up.

A accident could result! ***Because when booming up, the load will move laterally as well as vertically***

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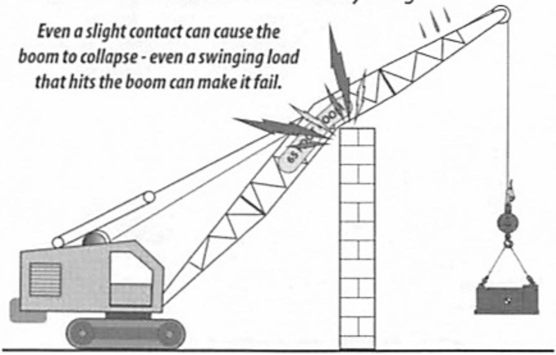
Crane Hazards during operations

Don't allow the boom to touch anything!

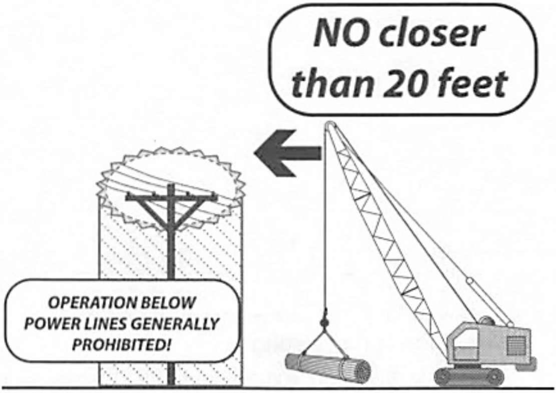


Even a slight contact can cause the boom to collapse - even a swinging load that hits the boom can make it fail.

Working near POWER LINES

Electrocutions caused by a crane, load, or load line contacting a power line have caused numerous fatalities. To prevent such accidents in the future, the new OSHA standard contains detailed, systematic procedures that employers must follow when operating cranes near power lines.

Refer to OSHA 1926.1407-1411 for specific details



NO closer than 20 feet

OPERATION BELOW POWER LINES GENERALLY PROHIBITED!

Note: If the line's voltage is over 350,000 volts, a 50-foot, rather than 20-foot, minimum clearance must be maintained.

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Crane Dynamics & Operations

QUALIFIED
OSHA
Signalperson

The use of a **dedicated spotter** is one of the safeguards used to prevent a crane, as well as its load and load line, from breaching the applicable minimum distance from a power line, and thereby prevent electrocution and electric shock.

To be considered a dedicated spotter, the requirements of OSHA § 1926.1428 (Signal person qualifications) must be met and his/her sole responsibility is to watch the separation between the power line and the equipment, load line and load (including rigging and lifting accessories), and ensure through communication with the operator that the applicable minimum approach distance is not breached.

Working Load Limits and Dynamic forces

The working load limits of cranes, and rigging equipment are determined from static loads and the appropriate design factor is applied to account for dynamic motions of the load and equipment. To ensure that the working load limit is not exceeded during operation, allow for wind loading and other dynamic forces created by the normal operational movements of the machine and its load. Always avoid the sudden snatching, swinging, and stopping of suspended loads. Rapid acceleration and deceleration can only increase the stresses on both the machine and the rigging.

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Audible Signals

These are signals made by a distinct sound or series of sounds, such as sounds made by a bell, horn, or whistle. As with other types of signals, the signal person and operator must clearly understand the meaning of the signals being used. When moving the crane, the following signals are used (ASME B30.5):

STOP: one short audible signal

GO AHEAD: two short audible signals

BACK UP: three short audible signals

New Signals

The standard allows room for development of new signal technology by permitting signals other than hand, voice, or audible signals to be used where the employer demonstrates that:

The new signals must provide at least equally effective communication as voice, audible, or Standard Method hand signals, - or - the new signals must comply with a national consensus standard (ASME) that provides at least equally effective communication as voice, audible, or Standard Method hand signals.

Voice Signals

These are signals given by oral communication, with or without amplification or electronic transmission. If this type of signal is used, the operator, signal person, and lift director (if there is one) must, before beginning operations, contact each other and agree on the voice signals that will be used. In most cases where voice signals are given, some type of electronic transmission and reception will be used.

When this is the case:

The device(s) used to transmit signals must be tested on site before beginning operations to ensure that the signal transmission is effective, clear, and reliable.

Signal transmission must be through a dedicated channel, except:

1. Multiple cranes and one or more signal persons may share a dedicated channel for the purpose of coordinating operations.
2. Where a crane is being operated on or adjacent to railroad tracks, and the actions of the crane operator need to be coordinated with the movement of other equipment or trains on the same or adjacent tracks.

The operator's reception of signals must be by a hands-free system.

Voice Signals

In situations where hand signals are not appropriate, voice signals are an option. Portable radios are often used. They should be tested before crane operations begin and they should use a dedicated channel. The crane operator must use a hands free device. Verbal signals should be short and clear.

They should include three key elements, spoken in this order:

1. **The function and direction**
2. **The distance and/or speed**
3. **Function stop**

The function names should be the same as the hand signals. Here are some examples of proper voice signals:

Boom up. Slowly. Slowly. Boom stop.
Lower load. 10 feet. 5 feet. 2 feet. Lower stop.

The function, such as Boom, Lower, Swing and Travel are spoken first, followed by the direction or speed. The signal to stop always has the function first, followed by stop. As with hand signals, voice communication between the signal person and the operator should be continuously maintained during crane movements.

Directions should be given from the direction perspective of the operator.

Voice Signals

Prior to Lifting Operations

Prior to beginning lifting operations using voice signals, the signals shall be discussed and agreed upon by the person directing lifting operations, the crane operator, and the appointed signalperson. Telephones, radios, or equivalent, if used, shall be tested before lifting operations begin. If the system is battery powered, extra batteries should be available at the job site.

Prior to commencing a lift, the operator and signalperson shall contact and identify each other.

- Begin by calling for the operator by name
- Operator will acknowledge with the signalperson's name

Voice Command Basics

The devices used to transmit signals shall be tested on site before beginning operations to ensure that the signal transmission is clear and reliable. Signal transmission must be through a dedicated channel. Exception: Multiple cranes/derricks and one or more signalpersons may share a dedicated channel for the purpose of coordinating operations.

The operator's reception of signals must be by a hands-free system. Cautions regarding radio use may include the following:

- Awareness of any explosive devices in general area (radio transmissions have been known to cause premature detonation of explosives that use electric detonators)
- Other electronics (potential for interference)
- Other radios nearby operating on the same frequency

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Voice Signals

The Crane operator and Signalperson MUST agree on which terms will be used.

Function	Initiate Function (and other acceptable phrases)	Terminate Function
HOIST	"Hoist" or "Hoist load"	"Hoist stop"
LOWER	"Lower" or "Lower load"	"Lower stop"
BOOM UP	"Boom up"	"Boom stop"
BOOM DOWN	"Boom down"	"Boom stop"
SWING	"Swing right" or "Swing left"	"Swing stop"
EXTEND BOOM	"Extend boom" or "Telescope Out" [1]	"Extend stop" or "Telescope stop"
RETRACT BOOM	"Retract boom" or "Telescope In"	"Retract stop" or "Telescope stop"
RAISE BOOM, LOWER LOAD	"Raise Boom and Lower Load"	"Boom stop and Load stop"
LOWER BOOM, RAISE LOAD	"Lower Boom and Hoist Load"	"Boom stop and Load stop"
DOG EVERYTHING	"Dog everything"	N/A
STOP	"Stop"	N/A
EMERGENCY STOP	"Emergency Stop"	N/A
USE MAIN HOIST	"Use main hoist"	N/A
USE AUXILIARY HOIST	"Use whipline" or "Use aux hoist"	N/A
TRAVEL (BOTH TRACKS) (Crawler Cranes ONLY)	"Travel both tracks forward" "Travel both tracks reverse"	"Travel stop"
TRAVEL (ONE TRACK) (Crawler Cranes ONLY)	"Travel left track forward" "Travel left track reverse"	"Travel stop"
TROLLEY TRAVEL	"Trolley in" or "Trolley out"	"Trolley stop"

---

[1] ASME B30.5 uses "EXTEND BOOM", OSHA uses "Extend Telescoping Boom". Some third party certification companies use "Telescope out" as the proper term, and may not allow other terms during some exams...always ask before taking an exam for signalperson with outside testing agencies.

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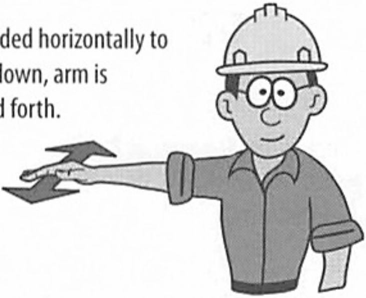
Hand Signals

STOP

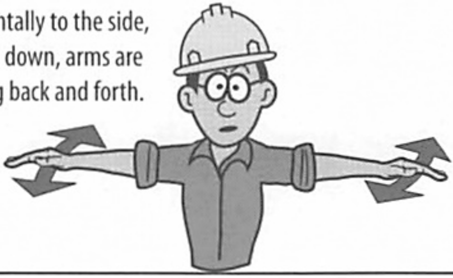
With arm extended horizontally to the side, palm down, arm is swung back and forth.



EMERGENCY STOP

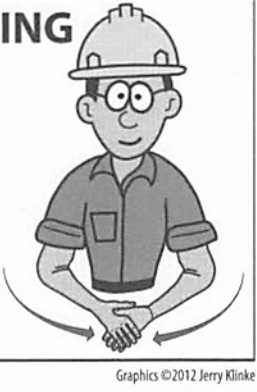
(Can be given by anyone)

With both arms extended horizontally to the side, palms down, arms are swung back and forth.



DOG EVERYTHING

Hands held together at waist level.



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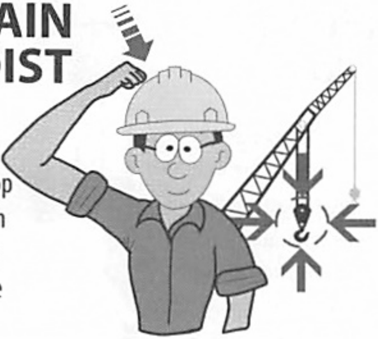
Hand Signals

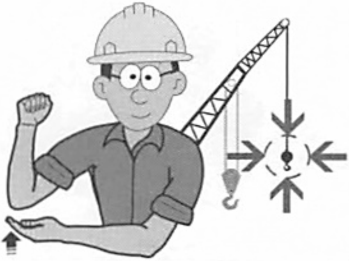
USE MAIN HOIST



A hand taps on top of the head. Then regular signal is given to indicate desired action.

USE AUXILIARY HOIST

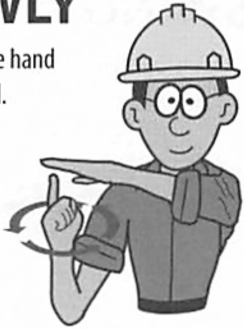
(use the whipline)



With arm bent at elbow and forearm vertical, elbow is tapped with other hand. Then regular signal is used to indicate desired action.

MOVE SLOWLY

A hand is placed in front of the hand that is giving the action signal.



(Hoist slowly up is shown in this example.)

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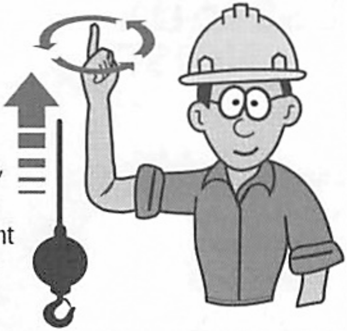
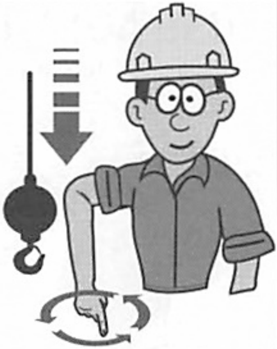
Hand Signals

HOIST
(load)

With upper arm extended to the side, forearm and index finger pointing straight up, hand and finger make small circles.



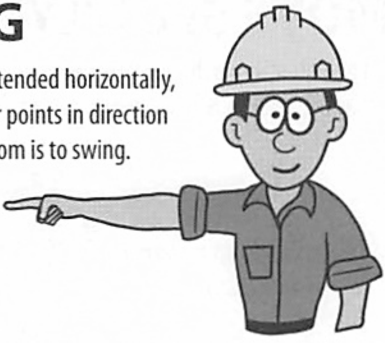
LOWER
(load)



With arm and index finger pointing down, hand and finger make small circles.

SWING

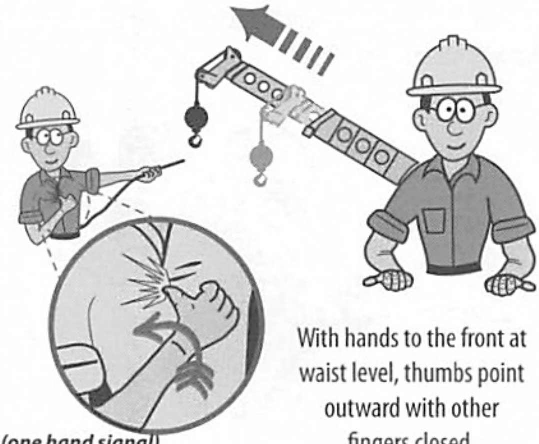
With arm extended horizontally, index finger points in direction that boom is to swing.



Graphics ©2012 Jerry Klinke

Hand Signals

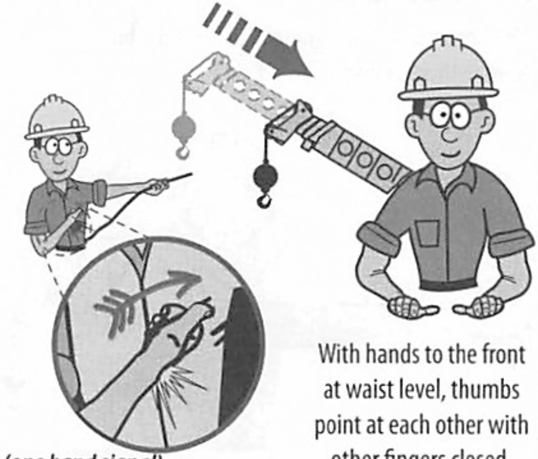
EXTEND BOOM



With hands to the front at waist level, thumbs point outward with other fingers closed.

(one hand signal)

RETRACT BOOM



With hands to the front at waist level, thumbs point at each other with other fingers closed.

(one hand signal)

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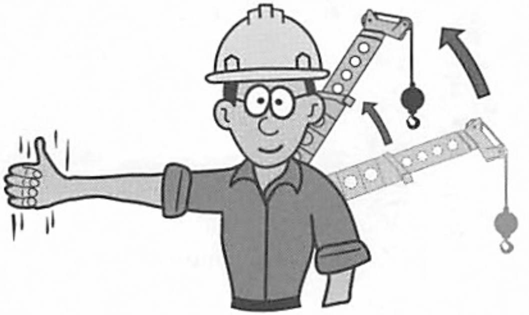
Hand Signals

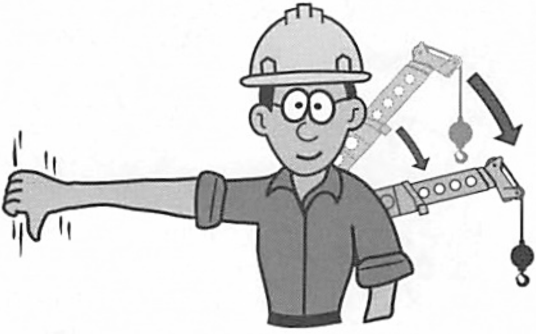
RAISE BOOM

With arm extended horizontally to the side, thumb points up with other fingers closed.



LOWER BOOM

With arm extended horizontally to the side, thumb points down with other fingers closed.



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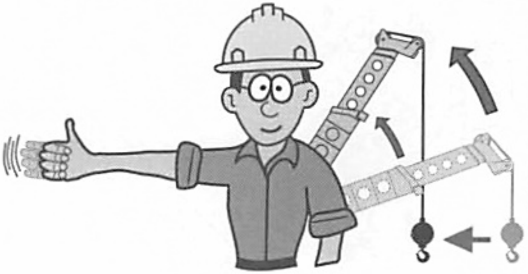
Hand Signals

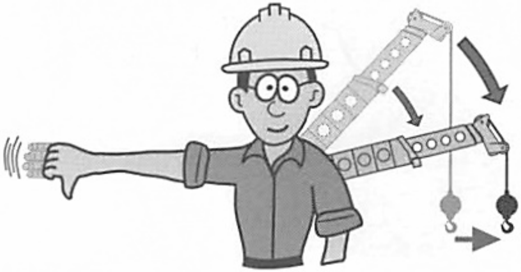
RAISE THE BOOM AND LOWER THE LOAD

With arm extended horizontally to the side and thumb pointing up, fingers open and close while load movement is desired.



LOWER THE BOOM AND RAISE THE LOAD

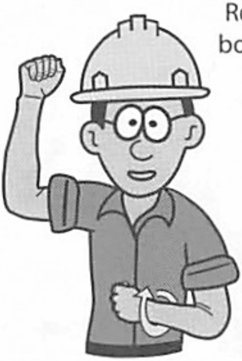
With arm extended horizontally to the side and thumb pointing down, fingers open and close while load movement is desired.



Graphics ©2012 Jerry Klinke

Hand Signals

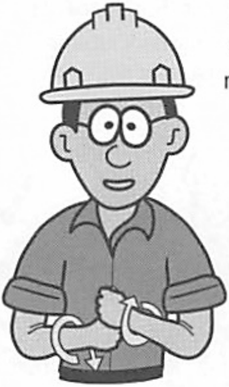
TRAVEL ONE TRACK



Indicate track to be locked by raising fist on that side. Rotate other fist in front of body in direction that other track is to travel.

Crawler Cranes Only

TRAVEL BOTH TRACKS



Use both fists in front of body, making a circular motion about each other indicating direction of travel, forward or backward.

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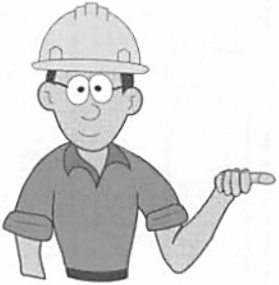
Hand Signals

TROLLEY TRAVEL

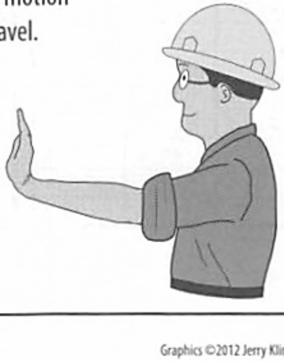
With palm up, fingers closed, and thumb pointing in direction of motion, hand is jerked in direction trolley is to travel.



Tower Cranes

TOWER TRAVEL

With all fingers pointing up, arm is extended horizontally out and back to make a pushing motion in the direction of travel.



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FRACTION/DECIMAL/MILLIMETER CONVERSION CHART

fraction	decimal	mm	fraction	decimal	mm
1/64	0.0156	0.3969	33/64	0.5156	13.0969
1/32	0.0313	0.7938	17/32	0.5313	13.4938
3/64	0.0469	1.1906	35/64	0.5469	13.8906
1/16	0.0625	1.5875	9/16	0.5625	14.2875
5/64	0.0781	1.9844	37/64	0.5781	14.6844
3/32	0.0938	2.3813	19/32	0.5938	15.0813
7/64	0.1094	2.7781	39/64	0.6094	15.4781
1/8	**0.125**	**3.175**	**5/8**	**0.625**	**15.875**
9/64	0.1406	3.5719	41/64	0.6406	16.2719
5/32	0.1563	3.9688	21/32	0.6563	16.6688
11/64	0.1719	4.3656	43/64	0.6719	17.0656
3/16	0.1875	4.7625	11/16	0.6875	17.4625
13/64	0.2031	5.1594	45/64	0.7031	17.8594
7/32	0.2188	5.5563	23/32	0.7188	18.2563
15/64	0.2344	5.9531	47/64	0.7344	18.6531
1/4	**0.25**	**6.35**	**3/4**	**0.75**	**19.05**
17/64	0.2656	6.7469	49/64	0.7656	19.4469
9/32	0.2813	7.1438	25/32	0.7813	19.8438
19/64	0.2969	7.5406	51/64	0.7969	20.2406
5/16	0.3125	7.9375	13/16	0.8125	20.6375
21/64	0.3281	8.3344	53/64	0.8281	21.0344
11/32	0.3438	8.7313	27/32	0.8438	21.4313
23/64	0.3594	9.1281	55/64	0.8594	21.8281
3/8	**0.375**	**9.525**	**7/8**	**0.875**	**22.225**
25/64	0.3906	9.9219	57/64	0.8906	22.6219
13/32	0.4063	10.3188	29/32	0.9063	23.0188
27/64	0.4219	10.7156	59/64	0.9219	23.4156
7/16	0.4375	11.1125	15/16	0.9375	23.8125
29/64	0.4531	11.5094	61/64	0.9531	24.2094
15/32	0.4688	11.9063	31/32	0.9688	24.6063
31/64	0.4844	12.3031	63/64	0.9844	25.0031
1/2	**0.5**	**12.7**	**1**	**1**	**25.4**

Multiplication table

X	0	1	2	3	4	5	6	7	8	9	10	11	12
0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	1	2	3	4	5	6	7	8	9	10	11	12
2	0	2	4	6	8	10	12	14	16	18	20	22	24
3	0	3	6	9	12	15	18	21	24	27	30	33	36
4	0	4	8	12	16	20	24	28	32	36	40	44	48
5	0	5	10	15	20	25	30	35	40	45	50	55	60
6	0	6	12	18	24	30	36	42	48	54	60	66	72
7	0	7	14	21	28	35	42	49	56	63	70	77	84
8	0	8	16	24	32	40	48	56	64	72	80	88	96
9	0	9	18	27	36	45	54	63	72	81	90	99	108
10	0	10	20	30	40	50	60	70	80	90	100	110	120
11	0	11	22	33	44	55	66	77	88	99	110	121	132
12	0	12	24	36	48	60	72	84	96	108	120	132	144

Typical questions sometimes asked on third party rigger tests.

1. Slings fabricated using wire rope clips should not be used in a _____ hitch *(page 31)*
2. When a chain sling is used in a choker hitch the capacity must be reduced by ____ % *(page 60)*
3. When an eyebolt or swivel hoist ring is used in a threaded-hole, the thread length should be _____ *(page 74)*
4. A 6X19 Wire rope slings must have a minimum clear length of ____ rope diameters *(page 211)*
5. The broken wire removal criteria for a single part wire rope sling is ___ *(page 211)*
6. A wire rope sling should be fabricated from ____ *(page 31)*
7. The ASME temperature range for synthetic web slings is _____ degrees F *(page 41)*
8. When placing the eyes of two slings into a hook, what is the maximum included angle? *(page 185)*
9. Carbon steel eyebolts should not be used above ___° F, or below ___° F *(page 210)*

- - - True or False - - -

1. A 4-leg bridle has the same rated capacity as a 3-leg bridle *(page 20)*
2. The correct way to determine the diameter of wire rope is to measure across the 2 crowns *(page 26)*
3. Core deterioration will result in fiber core wire rope slings if they are exposed to solvent and degreasing agents *(page 31)*
4. Capacity reduction for slings used in a basket hitch is required when the legs are more than 5 degrees from vertical *(page 14)*

see page 256 for answers

TERMINOLOGY AND DEFINITIONS

The following are a few of the specialized terms commonly used with hoisting and rigging operations.

- angle of choke: angle formed in a sling body as it passes through the choking eye or fittings.
- angle of loading: the acute angle between horizontal and the leg of the rigging, often referred to as horizontal angle.
- body (sling): that part of a sling between the eyes, end fittings, or loop eyes.
- bridle sling: a sling composed of multiple legs with the top ends gathered in a fitting that goes over the lifting hook
- D/d ratio: the ratio between the curvature taken by the sling, D, and the diameter of the component rope, d.
- design factor: ratio between nominal or minimum breaking strength and rated load of the sling.
- overhead lifting: the process of lifting that would elevate a freely suspended load to such a position that dropping the load would present a possibility of bodily injury or property damage
- rated load: the maximum allowable working load established by the sling manufacturer. The terms "rated capacity" and "working load limit" (WLL) are commonly used to describe rated load.

Phonetic Alphabet

Letter	Pronunciation
A	Alpha (AL fah)
B	Bravo (BRAH VOH)
C	Charlie (CHAR lee)
D	Delta (DELL tah)
E	Echo (ECK oh)
F	Foxtrot (FOKS trot)
G	Golf (GOLF)
H	Hotel (hoh TELL)
I	India (IN dee ah)
J	Juliett (JEW lee ETT)
K	Kilo (KEY loh)
L	Lima (LEE mah)
M	Mike (MIKE)
N	November (no VEM ber)
O	Oscar (OSS cah)
P	Papa (pah PAH)
Q	Quebec (keh BECK)
R	Romeo (ROW me oh)
S	Sierra (see AIR rah)
T	Tango (TANG go)
U	Uniform (YOU nee form)
V	Victor (VIK tah)
W	Whiskey (WISS key)
X	X Ray (ECKS RAY)
Y	Yankee (YANG key)
Z	Zulu (ZOO loo)

Note: The syllables printed in capital letters are to be stressed

Training Classes

It's easy to see why on-site training is our most requested service! We can assemble a customized training program for your company and your rigging activities:

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- Rigging Gear Inspection classes
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- OSHA Qualified Rigger training and certification
- Overhead Crane Operator classes

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http://www.acrp.net

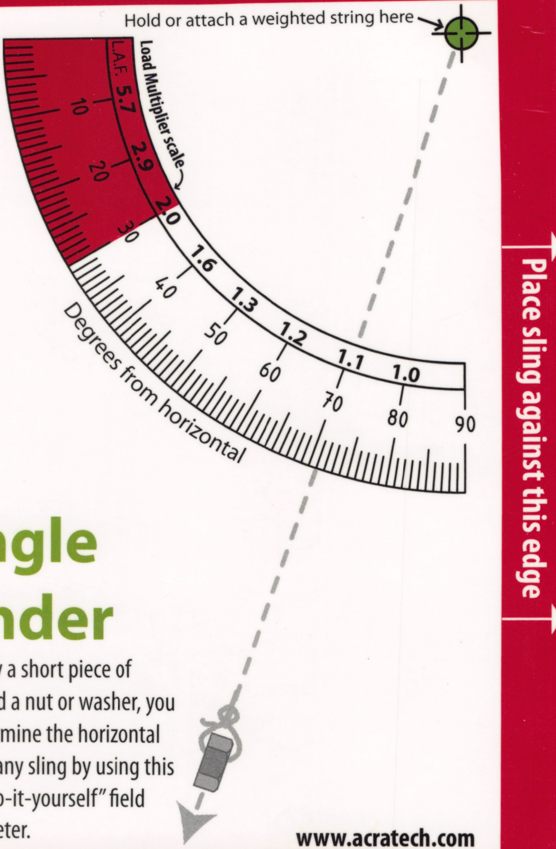
Answers to questions on page 252

A1: Choker
A2: 20%
A3: 1-1/2 x dia
A4: 10 x rope diameter
A5: 10 in a lay, 5 in a strand
A6: regular lay
A7: ASME 194°F, OSHA 180°F
A8: 90 degrees
A9: 30° & 275°F

True or False

All are TRUE

01495
9 781888 724165


Hold or attach a weighted string here
Load Multiplier scale
L.A.F.
5.7
2.9
2.0
1.6
1.3
1.2
1.1
1.0
10
20
30
40
50
60
70
80
90
Degrees from horizontal
Place sling against this edge

Angle Finder

With only a short piece of string and a nut or washer, you can determine the horizontal angle of any sling by using this handy "do-it-yourself" field inclinometer.

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